EDISON ELECTRIC CO.

SCIENTIFIC AMERICAN SUPPLEMENT. No. 1776

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1910, by Munn & Co., Inc.
Published weekly by Munn & Co., Inc., at 361 Broadway, New York.
Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXIX., No. 1776. NEW YORK. JANUARY 15. 1910. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

AN ELECTRIC DREDGER AND LOCOMOTIVE.

By Frank C. Perkins.

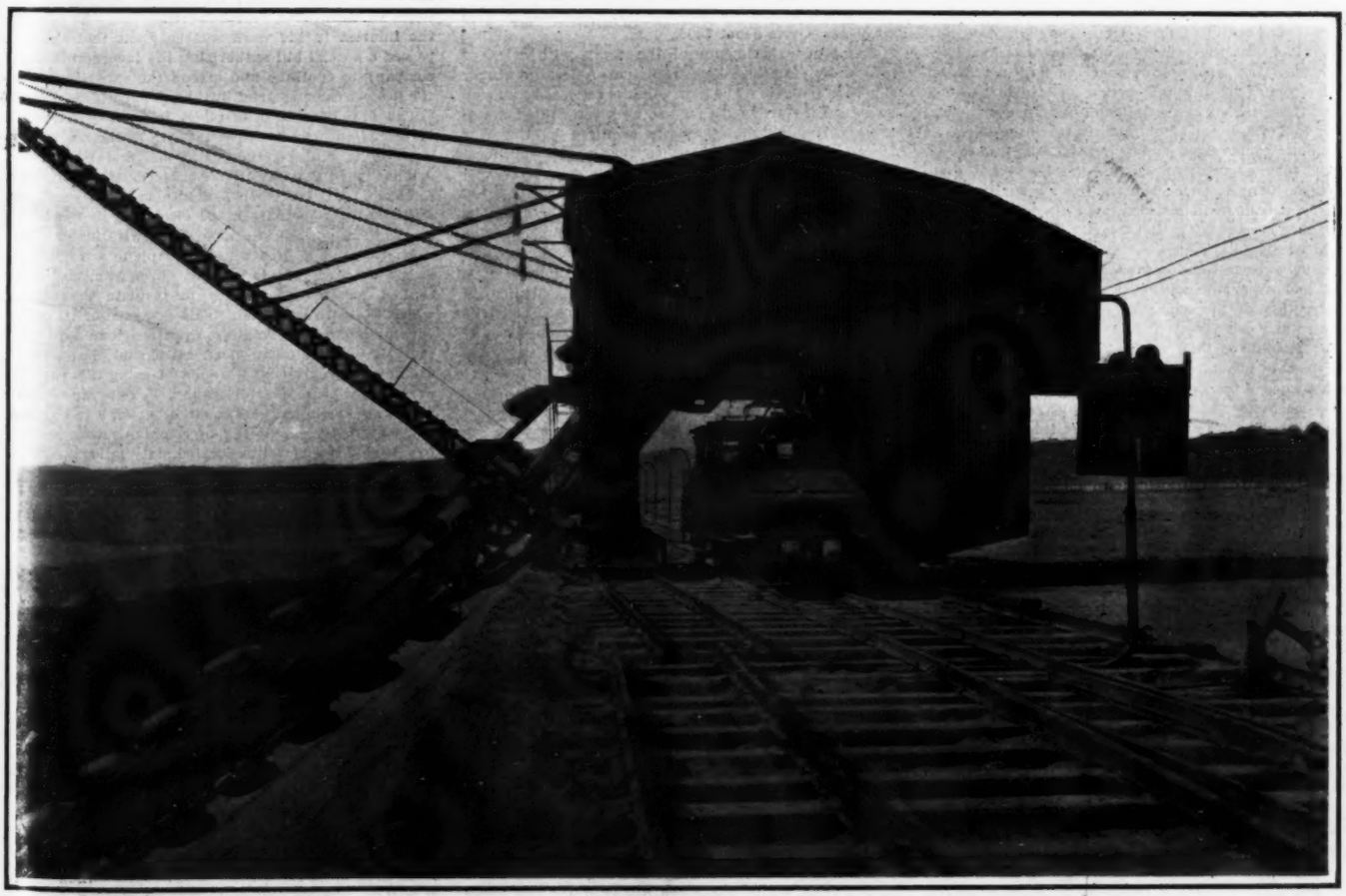
A most interesting electrically operated dredger at the German Marga lignite mine of the Isle Bergbau Aktien Gesellschaft has been installed by the Siemens-Schuckertwerke of Berlin. The lignite lies near the surface, but is covered with a layer of earth which has to be removed. Electric locomotives are provided to haul dump cars to and from an electric dredger of the bucket type utilized for loading the trains.

The Abraumbahn, operating at the Marga mine and at the Kauscherwerk near Petershain, N. L., is provided with two large locomotives of 250 horse-power and 350 horse-power capacity respectively, and a smaller electric locomotive of 60 horse-power capacity.

The overhead trolley construction of the Abraumbahn at the Braunkohlenwerk at Petershain may be noted in one of the illustrations, the overhead conductors being placed from 8 feet in height at the electric bucket dredge to 13 and 16 feet along other portions of the railway.

It is stated that by the use of the electric locomotive and electric dredge a saving in labor of six to ten

ELECTRIC LOCOMOTIVE HAULING A TRAIN OF DUMP CARS ON THE ABRAUMBAHN.



THE LARGEST OF THE ELECTRIC LOCOMOTIVES EMPLOYED IS TO BE SEEN UNDER THIS LIGNITE DREDGER.

A GERMAN ELECTRIC DREDGER AND LOCOMOTIVE HAULAGE EQUIPMENT.

engineers and firemen was effected with greater output than could have been produced with steam locomotives and a steam-operated dredger. The current for operating the electric dredge as well as the electric locomotive is supplied from a three-phase high-tension power-transmission line, a transformer station lowering the pressure and changing the current to a direct current of from 550 to 600 volts. The large double-truck electric locomotives noted under the electric bucket dredger at Petershain in one illustration, and as seen in the other illustration hauling a train of loaded dump cars at the Marga mine, weigh 25 and 44 tons respectively and are equipped with four motors connected in two groups and arranged to be connected in parallel or in series to provide two different speeds. The normal speed of these locomotives is 9 miles an hour. They are equipped with both hand and air brakes and air-operated sanding devices. The total height of the locomotives is only 8 feet, in order that they may readily clear the bucket dredger.

The smaller locomotive is also used at the Kauscherwerk at Petershain and has a capacity of 60 horse-power. It is provided with two pairs of driving wheels having a motor on each axle. Each of the two electric motors has an output of from 26 to 31 horse-power and is supplied with current of 500 volts pressure. There is a larger electric locomotive in service at the Kauscherwerk near Petershain on the Abraumbahn, which weighs 28 tons and has a capacity of 240 horse-power, four motors of 60 horse-power each, one motor being provided on each of the four driving axles and arranged in two groups for parallel and series operation. The drawbar pull of the electric locomotives is said to be 33 per cent of their weight, while with steam locomotives the drawbar pull is only 22 per cent.

WIRELESS SIGNALING IN AERONAUTICS.

EXPERIMENTS OF THE SIGNAL CORPS.

BY F. H. McLEAN.

THROUGH one or another of its branches the United States government has taken up wireless telegraphy experiments *via* both kites and war balloons, and public and private interests all over the country are energetically trying to combine wireless telegraphy and practical sky craft. If airships, balloons, and kites can be made to serve successfully as portable stations for wireless telegraphy, their value both in times of war and peace will be immeasurably increased. Wireless telegraphy will also be enabled to add further advantages to its already numerous points of superiority over all other forms of communication.

The United States Signal Corps, so far as is known, is in advance of all foreign military bodies in its invasion of this field; but while the American army officers early realized the many advantages that would accrue if war balloons could be utilized as wireless stations, there were several obstacles to be overcome before practical experiments could be accomplished. The most important one was the weight of a standard wireless apparatus of sufficient power for the exchange of messages between the ground and a war balloon at a lofty height. This obstacle has been overcome in a portable wireless set, which has recently been designed by Signal Corps experts, the first example of which has just been completed at the Signal Corps shops in Washington, under the direction of Electrical Assistant H. B. De Groot.

This compact little wireless equipment not only conforms to the requisite of minimum weight, but it solves the other chief problem presented in this new field, which was the provision of safeguards against a spark from the telegraphic apparatus igniting the explosive gas, that through design or accident might escape from the bag of the balloon. Among electricians there is a difference of opinion as to what danger of explosion would exist under normal conditions. Although some experts contend that there would be practically no danger, on account of the air currents created by a balloon in motion, the United States army aeronauts, recognizing the tragic consequence that would surely follow such an explosion at a high altitude, have been loth to take any such chances and have had every precautionary measure taken in the construction of the apparatus designed for their experimental work.

The weight of this wonderful new aerial set, all told, is only about 70 pounds and it occupies or rests upon a wooden frame of special design, which measures 30 inches in length, 17 inches in width, and 15 inches in height. The electrical energy for this cloud-climbing telegraph station is supplied from an ordinary 8-volt sparking battery similar to those used in automobiles. This part of the equipment weighs but 22 pounds as compared with a weight of 50 pounds in the corresponding section of the lightest portable wireless set that would have been available for this work had not the army experts evolved this special apparatus. To guard against the explosions, explained above, the spark gap has been covered so as to exclude all gas, and there is a similar protection for the interrupter contact. For all that this latter essential is housed in, it is always within view of the operator by means of a small mica window in the side of the case, and with the view of the contact thus available, any necessary adjustments can be made without opening the case. This new wireless set for military work in the clouds has the same type of key and telephone receiver found in the portable wireless sets which have lately made their appearance in the commercial field. A thoroughly unique feature is the "aerial," from which the sound waves are sent on their long journey. The aerial devised for wireless telegraphy *via* the scouts of the sky consists of three wires, each 150 feet in length, suspended from a cross arm attached beneath the keel or car of the balloon. It will be understood that these wires dangle below the cloud clipper, and thus the incoming messages, instead of being caught above the station, as in all earthly installations, will be caught below the station. In lieu of a ground wire the aerial telegraphers will make use of the wire netting which braces the balloon car. The cost of this wireless set was about $300.

The first experiments of the army with wireless telegraphy *via* aerial craft were made with an ordinary spherical balloon. The new wireless set just completed was designed primarily for use with the United States army dirigible "No. 1," lately acquired by the War Department. When in service the wooden platform carrying the electrical apparatus rests across the keel or skeleton framework of the balloon, being supported upon the two horizontal rods of the keel. The dirigible, which is destined to serve as Uncle Sam's first portable aerial wireless station, is 120 feet in length, and the car or keel which carries the wireless apparatus is made of spruce and is 60 feet in length by 2½ feet in width and 2½ feet in height. The balloon, which is equipped with a 20-horse-power motor, has a speed of 20 miles per hour and a lifting capacity of 1,350 pounds, of which 500 pounds are available for passengers, ballast, and fuel.

The electrical division of the United States Signal Corps has been busy with plans for wireless work *via* free balloons that would prove of great value in times of war; but while they have been thus employed, another branch of the Federal government has been looking into the possibilities of midair telegraph stations, designed to serve the pursuits of peace. Chief Willis Moore and his associates of the United States Weather Bureau have long taken a very keen interest in this subject, and experiments covering high-air work with both balloons and kites have been in progress for some time past at Mount Weather in Virginia, sixty miles from Washington. On this mountain peak the Weather Bureau has assembled a marvelous equipment for the exploration of the upper air. The primary interest of Prof. Moore in wireless telegraphy is as a means of transmitting storm warnings and weather forecasts, particularly the interchanges at sea between ships and shore stations. He is also convinced that this new communicative force has a rich future in certain other directions, for instance in life-saving work; and in all such spheres the use of kites or balloons to carry aloft the terminal wires would immensely increase the radius of action of the wireless system.

Wireless telegraphy *via* kites superseded by many years wireless telegraphy as we know it at the present time. Forty years ago, Mahlon Loomis, a resident of Washington, announced that he had solved the problem of transmission without wires by means of raising kites to great altitudes and telegraphing between them, and he claimed to have transmitted messages a distance of more than four hundred miles. At the time the interest in his work was so great that Congress passed a special bill authorizing the incorporation of a company to continue and extend the experiments, but the project came to grief in the panic of 1873.

The development of wireless telegraphy has again turned attention to the possibilities of the use of kites as sending and receiving stations, and it has been demonstrated that kites have exceptional qualifications for such functions. When a kite is flown at a great altitude a strong current of electricity is generated, especially when the kite is flown by wire instead of by cord. At Mount Weather, where piano wire is used, so strong a current is brought down from the clouds that it has been necessary to insulate the reel on which the wire is wound. This presence of the magic current in force is manifest even on clear days when there is no sign of an electrical storm. Experiments are now in progress with a view of using this captured current for wireless telegraphy. Telegraph instruments are cut in on the kite circuits, and a test is to be made as to the possibility of communicating between two kites flown at points located sixty miles apart.

REDUCTION GEAR FOR STEAM TURBINES.

THE great drawback to the rapid adoption of the steam turbine to ship propulsion is the high speed at which the propeller has to revolve. Marine engineers have long been looking for a satisfactory and economic method of obtaining a lower propeller-shaft speed than that given by directly attaching the screw to an extension of the turbine shaft, and many suggestions have from time to time been put forward to overcome this objection.

Those hitherto received with the greatest favor are based on the electric transmission of power, but it has been difficult to convince parties concerned that the total loss due to conversion would be lower than the loss of the efficiency of the screw at high speeds, let alone the introduction of machinery with its liability to break down, and increase of weight.

According to The Times, the problem has been solved, that paper reproducing a pamphlet received from Mr. George Westinghouse, entitled "Broadening the Field of the Marine Steam Turbine: The Problem and Its Solution," and containing a description of the Melville and Macalpine reduction gear.

According to this document the end has been accomplished by means of a helical reduction gear after that used in the De Laval turbine, but suited for the transmission of the highest powers. The wheels are in duplicate with the spirals running in opposite directions, thus balancing the thrust. The smaller gear is mounted on a floating frame, which has the effect of securing an equal pressure over the whole of the bearing surface of the teeth or gear.

The efficiency of transmission on a 5,000-horse-power turbine running at 1,500 revolutions per minute is stated to be 98.5 per cent, from which it is calculated that in the case of a vessel such as the Cunarder "Mauretania," the effective thrust would be obtained at the propeller with a reduction of 15 per cent on the steam consumption. This is derived from the supposition that the efficiency of the propellers at present is about 55 per cent, while propellers designed for the lower speed would have an efficiency of not less than 65 per cent. Incidentally the coal consumption would be decreased in proportion, the cargo-carrying capacity would be increased, and there would be a considerable reduction in labor and upkeep.

The advantages of the new system in connection with naval vessels are touched upon. We hope, however, to be able to acquaint our readers with some interesting details of this form of reduction gear as designed for the transmission of heavy power at no distant date.

It is reported that a large wireless telegraph and telephone station is to be erected at the Omaha shops of the Union Pacific Railway, where Dr. Frederick H. Millener will conduct wireless telegraph and telephone experiments. Dr. Millener hopes to develop wireless telephony to such an extent as to permit railway officials to keep in touch with trains, and thus govern their movements from sixty to one hundred miles from Omaha. If the system is developed as he expects, it will be possible for passengers on moving trains to carry on telephonic conversation within a radius of one hundred miles from Omaha.

ILLUMINATING ENGINEERING.

THE TECHNIQUE OF ARTIFICIAL ILLUMINATION.

THE phrase "illuminating engineering" is of comparatively recent origin. We believe it is American. Although not particularly euphonic, it will perhaps serve, as well as another, to indicate a sphere of work which is certainly a branch of engineering, and is probably of sufficient importance to justify its claim to be considered as an independent entity. As we understand it, the illuminating engineers claim the whole field of artificial illumination as their sphere. They point out that, up to the present, problems of illumination have been left to the arbitrament of engineers or others specially interested in some one of the various systems of lighting, or have been treated as of little importance, and dealt with in a haphazard or careless fashion. They claim that it shall be their special business to deal with such problems, and weighing, without prejudice, the advantages and disadvantages of the various systems, to recommend the most suitable for each particular place or circumstance. Further studying the subject, they will be competent to advise on the size and position of lights, on their character, on the color of walls, and on other attendant matters, so that each particular installation may obtain the most suitable and efficient system for the expenditure involved. They also point out that many data are available relating to the distribution of has been undertaken at one time and another, so that much data is available relating to the distribution of light, the effect of color, and kindred matters. It shall be their business to co-ordinate and extend these data, build up a rational practice, and evolve rules dealing with the amount of light necessary for particular positions or purposes.

Progress in the art of artificial illumination during the last fifteen years or so has been remarkable. This progress has not, however, been brought about by impartial investigators or illuminating engineers weighing the merits of acetylene against those of petroleum, or of gas against electricity. It has rather been brought about by the extremists—the men who from prejudice or business interest have concentrated their attention on one or other form of lighting, and have struggled to improve its mechanisms and applications, so that it could better compete with its rivals in the field. Strictly speaking, the illuminating engineers do not claim that improvements and future progress will necessarily come from them. Their field is the improvement of applications. None the less, on an average, one may expect the general progress of an art, apart from radical departures, to come from the specialists in that art. This is a small point, but helps to throw doubt on the supposed necessity for any such body of illuminating engineers. In view of the remarkable progress that has been made without them, it becomes questionable if there is really any unoccupied field waiting their attention, and it is doubtful if any such professional body will really grow up.

We doubt if the question of rational illumination is as complex as the illuminating engineers would have us believe. In a large number of cases at the present time, perhaps in the majority, lighting is certainly carried out in an unsatisfactory way. Frequently the only criteria are the size of the lights and the size of the room—so many 16-candle-power lamps for such an area, quite irrespective of the color of the walls, the nature of the furniture, or the purpose for which the room is to be used. None the less, the treating of such matters in a rational manner is, after all, a simple question, and we are inclined to think that some rough general rules as to the candle-power per square foot required for given purposes, together with working information on the reflecting power of various surfaces and the distinction between diffused and indirect lighting, will in a year or two be commonplaces with those interested in any way in artificial illumination. No doubt the spread of this information will be much assisted by the illuminating engineering societies, and in this way they may do much useful work. None the less, the matter with which they are dealing is a simple one, and the information they are able to disseminate is likely to be collected and utilized by architects, house-decorators, and others who would never dream of calling themselves illuminating engineers. The satisfactory lighting of, say, a concert hall, is child's play compared with the difficulties of adequately heating or ventilating it.

There are at the present time distinct signs of a growing appreciation of the more important underlying principles of illumination among those responsible for lighting work. This appreciation has grown up as a sort of by-product of the great development in the number and efficiency of illuminating systems. Manufacturers of special appliances, or of new departures, have been led to investigate the real advantages or disadvantages of their systems, and, advertising the former, have led opposition manufacturers to attempt to minimize such advantages by bettering them. None the less, much educational work still remains to be done, and the illuminating engineering societies have a large field for the propagation of their doctrines. There is still far too much attention concentrated on the question of candle-power, and far too little on that of illumination. Candle-power is, of course, a good selling feature in lamps—what salesmen call "a talking point"—and one cannot be surprised that it is kept so prominently before buyers. But apart from this tendency to fix attention on questions of candle-power, purely as a matter of business, there are many signs of a growing appreciation of the fact that the really important matter is illumination, and not light at all. Much credit for this better understanding must be given to the early work of Sir William Preece and Mr. Trotter with portable street-photometers.

There is no question but that great advances in artificial illumination are still to come. For the moment the most hopeful field would appear to be in the direction of a more deliberate employment of selective radiation with its attendant increased efficiency. In one sense all sources of artificial light are chosen from the point of view of selective radiation. No man employs a peat fire to illuminate his house, because in the spectrum of a peat fire so much of the energy lies outside the visible range, in the low-frequency heat rays, that it forms an abnormally inefficient light-producer. In the sense that all sources of light are chosen so that their spectra show a reasonable proportion of the rays lying within the visible range, all lighting may be said to be by selective radiation. But, as Dr. Steinmetz has pointed out, there is no sense in talking about selective radiation unless we say exactly what we mean by it. His definition of a body giving selective radiation is one in which the intensity of radiation throughout the spectrum is distributed differently from that found in the spectrum given by a theoretically black body. In this sense a Welsbach mantle gives selective radiation. The spectrum is continuous, but the intensity is high in the greenish-yellows, and the efficiency of the mantle as a source of light is consequently high. It is possible, however, to find sources of light which give spectrum lines, or bands, of abnormally high intensity, with a marked absence of the colors corresponding to other rates of vibration. The mercury-vapor lamp is a case in point. Sources of light of this type naturally have marked color, and depart seriously from a white-light standard. Selective radiation of either of these types is suitable for artificial illumination. The spectrum band type will normally be the most efficient, since the Welsbach-mantle type of continuous spectrum contains a large amount of low periodicity radiation, which is useless for illumination. The spectrum band type will, however, be useless for many purposes, owing to its marked color.

It is usually supposed that a white light, approximating to daylight, should be aimed at in illuminants. Lamps, however, giving a light of this kind cannot be the most efficient, since the light of one part of the spectrum is always most efficient for any specific purpose. Further, it is doubtful if the public really desire a white light; they are used to artificial lights of the yellowish variety, and for indoor lighting especially, when the feminine part of the population have to be pleased, it is probable that "warmer" lights of the yellowish-red variety will always be preferred above any approximation to daylight. None the less, extreme color, as in the mercury-vapor lamp, is objectionable. Owing to the almost complete absence of low-periodicity radiations of little illuminating power in this lamp, it is the most efficient light we have; but its color, or rather its absence of color, renders it unsuitable for most purposes. It is valuable for situations in which light, and light only, is wanted, or for places in which its peculiar appearance is an advantage, such as the outside of a music hall; but one has only to conceive the effect of such a light running amuck in a ballroom, to realize its limitations. Although the mercury arc is the extreme case, the comparatively limited color range of the flame arc is sometimes a disadvantage. We remember a case in which a flame arc, deficient in reds, placed in a greengrocer's shop was ultimately rejected owing to the unripe appearance of tomatoes in its light. No doubt there are a great many other similar cases.

All incandescent solid bodies give continuous spectra so that for selective radiation in the extreme sense we must look to vapor lamps of one sort or another. The common examples are the mercury and flame arcs. Up to the present no success has attended efforts to modify the color of the former. By combining the light given by a mercury-vapor lamp with that given by a metal filament or a Welsbach mantle, a fair approximation to white light is obtained; but such combinations are inconvenient, and have been little used. The flame arc offers a more hopeful field. By varying the impregnating material, a fair range of color may be obtained, and it is quite possible, within limits, to select a composition giving a continuous spectrum over a useful part of the white-light range, with comparative darkness above and below. Future developments are likely to take place along these lines, and lamps or carbons for specific purposes will probably be manufactured. We hardly expect such refinements as the introduction of carbons specially suited to the complexion of tomatoes, but a certain specialization in this direction will probably be seen. The light most suitable for a foundry is by no means necessarily equally suited for street illumination or for lighting a park or other place where there is much vegetation.

The development of lighting, and the spread of information in reference to it, will probably result in certain definite degrees of illumination becoming recognized as necessary for special purposes. Professor Silvanus Thompson, in his able presidential address to the newly-formed Illuminating Engineers' Society, on the 18th inst., stated that a regulation is in force in Holland calling for an illumination of 10 to 15 candle-meters in factories. It is likely that some such definite rule will in time take the place of the present unsatisfactory "adequate illumination" of our own factory rules. Prof. Thompson also pointed out the importance of this matter in reference to schools, but confined his attention and criticism mainly to the question of the size of windows and the amount of light on the desks during the daytime. Certainly the daylight in a school is more important than the artificial illumination, but the fixing of any standard is obviously much more difficult. Any photometric readings taken in the daytime must be so dependent on the weather and state of the sky that obviously any rules which are made must be so broad that in the long run they are likely to be of little more value than the mere demand for "adequate illumination," to which he objects.—Engineering.

ELECTRO-ACOUSTIC METHOD OF MEASURING DISTANCES AT SEA.

MR. DEPRIX, an American electric engineer, has, according to Cosmos, invented an ingenious method of measuring the distance of a vessel which cannot be seen because of darkness, fog, or intervening objects. This method is based on the difference between the velocities of sound and Hertzian waves.

At the receiving station, which we may suppose to be a lighthouse or semaphore station on the coast, a train of clockwork causes a pointer to move over a divided dial at the rate of one division per second. The clockwork is started by a Hertzian wave, which is sent out by the ship simultaneously with a sound wave produced by a gun, siren, or whistle. As the propagation of Hertzian waves is practically instantaneous the pointer may be regarded as starting at the instant at which the sound wave leaves the ship. The observer on shore watches the pointer and notes its position at the moment the sound reaches his ears. The distance of the ship is then obtained by multiplying the number of divisions traversed by the pointer by the velocity of sound (about 1,100 feet per second).

The position of the ship can be determined with greater precision if the Hertzian and auditory signals are received by two shore stations, which can communicate with each other by telegraph. The distance of the ship from each station having been found, the ship's position on the chart will be at the intersection of two circular arcs drawn about the stations, as centers, with radii equal to the two distances. The result might be communicated to the ship by wireless telegraphy.

A still better plan would be for each of the chain of coast stations to emit, at regular intervals, simultaneous Hertzian and auditory signals (the stations being distinguished by peculiarities in the signals, as lighthouses are now differentiated). Then any ship provided with the simple receiving apparatus described above could determine its position at any time and make its way safely to port.

SUGAR MAKING.

THE CONTINUOUS DIFFUSION PROCESS.

BY H ROUSSET.

THE production of sugar and alcohol form one of the principal industries of France, and the value of the products obtained yearly from the sugar beet exceeds that of the annual production of iron or coal. The processes of sugar making have attained so high a degree of perfection that 99 per cent of the sugar contained in the raw material is recovered, and the lump sugar which is sold in the shops is as pure as any of the "chemically pure" products of special laboratories.

The first operation to which the washed and chopped beets are subjected consists in dissolving out of all their soluble ingredients. The saccharine liquid thus obtained is purified and from it is extracted sugar or, after fermentation, alcohol.

Nearly half a century ago the old method of extracting the juice by pressure was replaced by the process of diffusion, in which the chopped beets are successively treated with solutions, each of which contains less sugar than the preceding. In other words, the water first comes in contact with the most nearly exhausted beets and the weak syrup thus produced is gradually strengthened by contact with less and less exhausted beets until it reaches the fresh beets which still contain all their sugar. The process is conducted in a "diffusion battery" of 12 or 16 cylindrical sheet iron vessels, which are arranged in a circle on a straight line are periodically filled and emptied by the operation of numerous cocks which control a very simplex system of pipes. Without entering into detail, it is evident that the operation of such an apparatus, involving periodic flow of the juice, is very difficult. In practice, it often happens that the flow of juice is irregular and the sugar is incompletely extracted.

Hence many inventors have attempted to devise automatic and continuously-acting apparatus. The problem now appears to have been solved, after many fruitless efforts. In Austria, within the last two years, several factories have adopted a continuous diffusion process invented by Von Hyross and Rak, which has given complete satisfaction. The Hyross-Rak apparatus (Fig. 1) comprises four tall, conical diffusion vessels, assembled with their small ends alternately below and above, and with the small end of the first three vessels communicating with the large end of the next vessel. The vessels are also connected by pipes which run from the middle of the fourth vessel to the top of the third, from the middle of the third to the bottom of the second and from the middle of the second to the top of the first. The beets are forced downward through the first and third vessels, and upward through the second and fourth vessels by screw blades, geared to shafts above and below the apparatus. The fresh beets are conveyed by a chain pump from the cutting machine to a hopper above the first vessel, *D*, and the exhausted beets are discharged from the top of the fourth vessel, *H*. Water enters at the bottom of the fourth vessel, flows, by means of the small pipes, through the other vessels, continually taking up sugar from the beets which it encounters; and is discharged, as a strong syrup or juice from the lower part of the first vessel, *D*. In the uppermost section, *I*, of the first vessel, the fresh beets are thoroughly mixed with the juice, already rich in sugar, which flows in through the small pipe from the second vessel. In the succeeding and longer section, *II*, diffusion takes place until the liquid inside and outside the cells of the beets is of equal concentration. In the next section, *III*, the juice is pressd out of the beets by the contraction of the walls of the vessel and the enlargement of the shaft of the screw, and flows through perforations in the inner wall to the outlet pipe, which delivers it to the refining and evaporating apparatus. From section *III*, the beets, still compressed to prevent re-absorption of liquid, are forced by the screw into the wide horizontal passage *IV*. Here they are mixed, by vertical paddles at the bottom of the screw, with juice which flows in at *G* from the third vessel and which is weaker than the juice which they have already encountered. The mixture passes into the second diffusion vessel, which is similar to the first except that it is inverted, and in which the same operations are repeated, the juice flowing into the upper section of the first vessel, and the compressed beets passing into the mixing chamber, *R*, of the third vessel where they are stirred with the weak juice which flows in from the fourth vessel. In this way the beets and the liquid pass in opposite directions through the four (or six) vessels which constitute the diffusion battery. The temperature of the juice is maintained and regulated by steam coils in the mixing chambers.

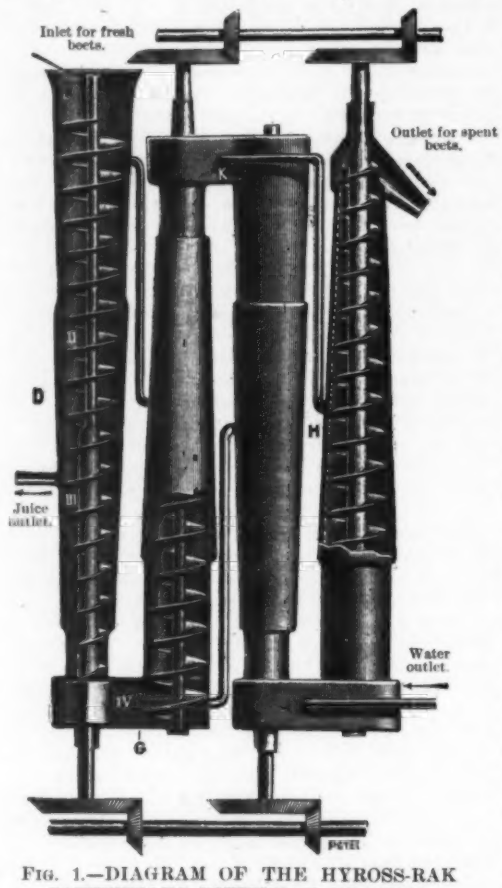


FIG. 1.—DIAGRAM OF THE HYROSS-RAK CONTINUOUS DIFFUSION PROCESS.

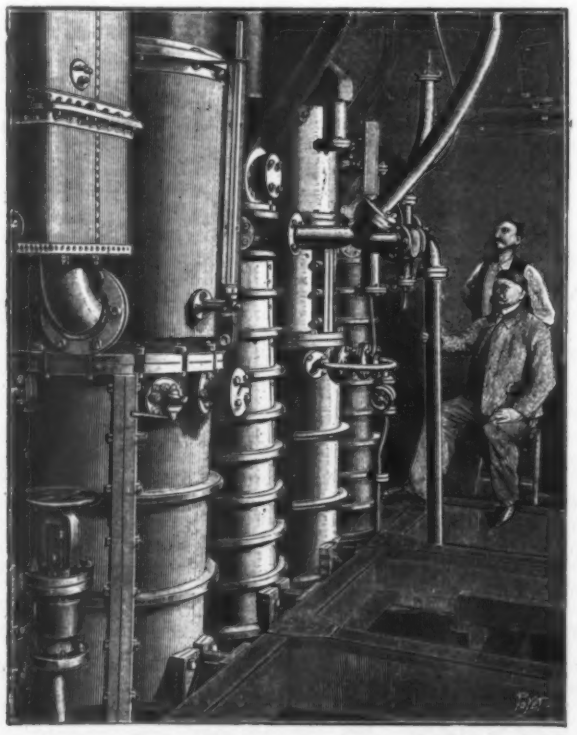


FIG. 2.—HYROSS-RAK CONTINUOUS DIFFUSION BATTERY.

FIG. 3.—THE BATTERY WITH THE WALLS OF THE DIFFUSION VESSELS REMOVED, SHOWING THE BEET PULP IN SPIRAL LAYERS, SEPARATED BY THE SCREW BLADES.

All continuous industrial processes possess the advantages of increased and more regular production, diminution in the number of workmen and comparative independence of their attentiveness and good will, but the Hyross-Rak presents still other points of superiority over the discontinuous diffusion processes commonly employed. There is no waste water resulting from the pressing of the beets and the washing of the diffusion vessels. Hence there is a saving both in water and in waste products, which must be purified, at considerable expense, before they can be thrown into streams. The water employed for diffusion is the ammoniacal water which is obtained by condensing the vapors of the evaporating pans. The juice is richer than the product of the discontinuous process, and the spent beets form a more nutritious fodder, as they contain 20 per cent, instead of 10 per cent of dry matter. The apparatus occupies much less space than is required for the ordinary process, as is shown by Figs. 2 and 3. Finally, the diminution of the quantity of water which must be pumped, heated and evaporated results in a saving of fuel which may exceed $1,000 annually for an establishment of average size.—*La Nature.*

KEEL WATER AND ITS CAUSE.

A PHYSICAL EXPLANATION.

BY NAVAL CONSTRUCTOR ULFFERS.

PROF. OSTWALD, in a recent article, describes that often observed, but little understood, phenomenon which is commonly called keel water. In connection therewith, Ostwald describes the phenomena of surface tension and the effect of thin layers of oil upon the surface tension of water. In these phenomena he finds the explanation of the effect of oil in stilling the waves, which has frequently been observed, and in recent years has been utilized in life-saving operations in heavy seas. But this modification of the surface tension does not suffice to explain the origin of keel water, the essential cause of which is to be sought in a very different field. If the oil which is expelled by a steamer were the sole cause of the smooth track which the vessel leaves behind it, the width of this track would not agree so exactly as it does with the width of the hull. In consequence of the great extensibility possessed by layers of oil floating upon water, the track would vary in width according to the quantity of oil exuded rather than in proportion to the width of the vessel. Undoubtedly the steam which escapes from a piston engine lubricated with oil sometimes carries considerable quantities of oil with it, but this oil does not, as a rule, become mixed with the condenser water or escape from the ship, for modern marine engines use surface condensers, in which the exhaust steam surrounds a system of pipes which are cooled by an internal circulation of sea water. Consequently, the steam and the condenser water do not come into contact except in case of leakage. The quantity of oil which escapes by reason of such leakage is too small and too uncertain to produce the well-marked and regular phenomena of keel water. Furthermore, oil is not used in the lubrication of steam turbines, yet turbine steamers produce keel water in an especially high degree. Finally, careful observation has demonstrated that sailing vessels are not, as was formerly supposed, entirely free from keel water. The writer has often observed a very distinct and regular formation of keel water by very small yachts. The fact is that every body which is drawn along the surface of the water leaves behind it a smooth track which is wider, more conspicuous, and more permanent in proportion to the size of the body and its velocity. In order to explain the formation of this track, or keel water, we must study the phenomena of the resistance opposed by water to the motion of a solid body. If a teaspoon is half immersed in a cup of coffee, and drawn through it with its convexity in front, it is easy to observe that the liquid flows to both sides of the spoon, and that two funnel-shaped eddies are formed at the edges of the spoon. It can also be observed that a certain interval of time is required for the formation of these eddies, and that they persist long after the cause which produced them has ceased to act. This simple and instructive experiment has been developed in scientific form by Prof. Ahlborn, two of whose interesting experiments are here described and pictured. Fig. 1 shows the eddies and disturbance in the water produced by the movement of a flat plate with its plane normal to the surface, and Fig. 2 shows the corresponding effects produced by an oval or more ship-shaped body.

These eddies furnish the basis of the explanation of keel water. Every rotating body tends to preserve its axis and plane of rotation unchanged. This is observed in the common top and in gyroscopic apparatus of all kinds, also in the child's hoop and the bicycle. The gyroscopic action of swiftly rotating masses is frequently utilized in maintaining a direction of motion unchanged, as, for example, in the launching of torpedoes, and, quite recently, in diminishing the rolling of vessels (Schlick's marine gyrostat). Similarly, a gyrostatic compass, the axis of which remains permanently parallel to that of the earth, has been recommended and to some extent employed as a substitute for the magnetic compass. The eddies produced by the motion of a body through water possess the same gyrostatic properties, and consequently tend to maintain their axes of rotation vertical of their planes of rotation horizontal. Consequently, they have a smoothing effect upon the surface of the water, and successfully resist the disturbing action of the influences which ordinarily give rise to the smallest waves and ripples. The large waves are not affected by these eddies, which are simply carried up and down upon their surfaces. The result is the formation of the smooth track, destitute of small waves, which has an oily appearance and is known as the keel water. But in destroying the small waves the eddies are finally themselves destroyed, and the surface resumes its normal appearance. The effect of the eddies lasts for a time which depends upon the size and velocity of the vessel which produces them. For this reason, the keel water is commonly observed only in the case of steamers, which, as a rule, are both larger and swifter than sailing vessels. Furthermore, the commotion produced in the water by the paddle wheels and screws increases the formation of eddies and the general agi-

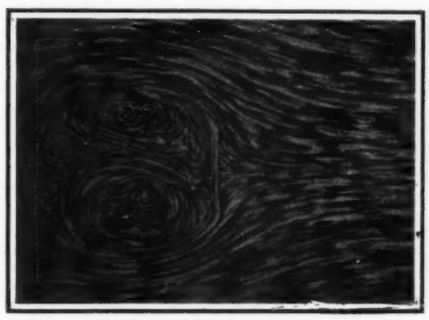


FIG. 1.—EDDIES PRODUCED BY A FLAT PLATE.

tation of the water. By careful attention, it may be observed that all eddies which are formed at any part of the ship's side or are caused by the paddle wheel or screw come together in the keel water, and trail in a long series in the smooth wake behind the ship, which is sharply distinguished from the rough water on either side.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Kosmos.

THE REFRACTIVITY OF RADIUM EMANATION.

SEVERAL English physicists have been endeavoring to determine the refractive index of radium emanation, not only for the intrinsic interest of a knowledge of the refractivity in question, but also because of the great probability of the emanation's being one of the series of non-valent elements. Lord Rayleigh, Alfred W. Porter, and Clive Cuthbertson have been working in this field. All of them have given accounts of their work in Nature.

Because of the minute quantity of emanation available, the refractometer employed must necessarily be minute. Messrs. Porter and Cuthbertson use a tiny interferometer vessel, 2.271 millimeters long and 0.71 millimeter in diameter, in which they compress the emanation through the capillary tube by means of a mercury column. Set up in the path of the green beam separate spectroscopically from the light given by a Bastian mercury lamp, the light passing through was

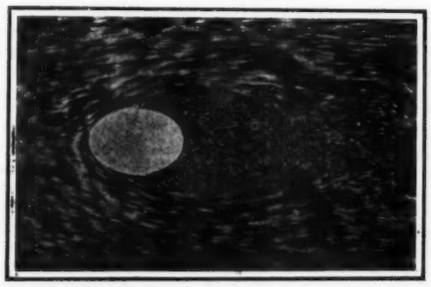


FIG. 2.—EDDIES PRODUCED BY AN ELIPTICAL PRISM.

examined through an astronomical eyepiece, with the result that interference bands were obtained so clear that they could be measured micrometrically to the hundredth part of a band. The method of a determination, in general outline, consisted in alternately increasing and decreasing the pressure of the contained gas from and back to a practically zero value and observing the number of interference bands which passed over the cross-wire of the micrometer. In order to determine the efficiency of the arrangement, observations were made for the refractivity of air, with the result that an accuracy to within about 2 per cent could be relied upon, so far as the optical part of the experiments is concerned.

The real difficulties begin, however, with the emanation itself. The rapid generation of impurities, originating in part in the action of the emanation upon the resinous cement employed for fixing the parallel plates, together with the lack of a knowledge of what these impurities are, made it impossible to calculate the index of the emanation from the experimental results, although it was perfectly easy to measure the refractivity of the mixture of gases existing at any time. The only datum known in regard to the composition of the mixture was the approximate percentage of emanation present, this being found by measuring the γ radiation from it. The direction in which the refractivity lies may, however, be inferred with probability from the following observations. Starting with emanation given off from a solution and containing a very large amount of impurity, this was purified, first, by explosion, drying, and absorption of CO_2, and afterward by freezing in liquid air and pumping off the volatile impurities according to well-known methods. Testing the refractivity from time to time, its value—at first of the order of that of air—did not sensibly rise until the volume was about one cubic millimeter. Continued purification increased the refractivity, and the highest values obtained in the experiments were 0.000840 when the volume was 0.205 cubic millimeter (at atmospheric pressure) and 0.000916 when the volume was 0.128 cubic millimeter at atmospheric pressure. The quantity of emanation was approximately the same for both these measurements, and equaled the quantity in equilibrium with 0.178 gramme of radium. Of course, if it could be assumed that the impurities were the same in kind on the two occasions it would be possible to estimate from these data the value for the pure substance, but the failure of this method on many occasions to give consistent results took away all belief in its applicability. For purposes of comparison the higher of the above values is about twenty-six times the value of helium, while the value for xenon—the highest for any known gaseous element—is twenty times, and for CO_2 thirteen times, the value of helium.

One source of difficulty so long as the available amount of emanation is so small is that the maximum pressure to which it can be raised in the apparatus is only a few (7 or 8) centimeters. The capillary correction thus becomes exceedingly important, and Sir W. Ramsay has given reasons for believing that the capillary behavior of mercury is quite abnormal in the presence of emanation. Another serious difficulty was that, under the action of the emanation, the silver (or platinum) through which the light had to pass gradually became opaque. The consequence was that the apparatus had each time to be dismounted after a couple of days, the faces re-polished, re-silvered, and re-installed before a new experiment could be begun. This source of inconvenience would, of course, not be present in apparatus similar to the Young-Arago method employed by Lord Rayleigh or in a Jamin refractometer (which is the more satisfactory of the two), but we do not think that it would be possible to obtain an equal optical efficiency with these arrangements.

The amount of success attending these experiments—small though it may seem to be—leads to the hope that if the amount of available emanation were increased a few times only, an approximate value of the refractivity would be ascertainable. Even at the present time this might be effected by means of a collaboration among all those who possess large quantities of radium.

National forestry operations in Italy have been carried on for forty years, and a report just issued by the Secretary of Agriculture of that country shows that the government are conducting a vigorous policy of afforestation in order to remedy the ruinous conditions which followed the destruction of trees in the past. During the last thirty years 122,000 acres of government land have been planted in twenty-five provinces, of which area 69,000 acres were planted in 1907, and this work is being carried on so rapidly that only about 36,000 acres of government land now needs planting. The government have also distributed great numbers of young trees and seeds for planting private property. Work of such an expensive nature in a country where the demands for national funds are so numerous and pressing as in Italy is a significant commentary on the value set upon afforestation where the experience of many centuries furnishes considerable information of unquestioned value regarding matters of this nature.

THE CUSTOM OF WAR

ANCIENT AND MODERN CODES.

By the custom of war is meant that code of laws and usages, mostly unwritten, which regulates the conduct of belligerents toward each other. It is little more than a century since this custom of war permitted the general of a besieging army to encourage his men with the promise than when the place fell they would be allowed to sack it for a day and plunder freely. Such a right is never now exercised against civilized enemies; but the old practice has, it is to be feared, been more than once connived at, to say the very least, in the case of "uncivilized" foes. To go back a little farther, one finds honorable soldiers summoning a castle or fortress to surrender, and warning the garrison that, as the place was considered to be untenable, they would give no quarter if they were forced to storm it.

We have a reference to this custom in one of Major Dugald Dalgetty's stories of the glorious wars of Gustavus Adolphus, when he tells Menteith:

"I once saw a brigade of Irish, at the taking of Frankfort upon the Oder, stand to it with sword and pike until they beat off the blue-and-yellow Swedish brigades, esteemed as stout as any that fought under the immortal Gustavus. And although stout Hepburn, valiant Lumsdale, courageous Monroe, with myself and other cavaliers, made entry elsewhere at point of pike, yet had we all met with such opposition we had returned with great loss and little profit. Wherefore these valiant Irishes, being all put to the sword, as is usual in such cases, did nevertheless gain immortal praise and honor."

Scott here makes the major speak the language of his time. The refusal of quarter was defended on the ground that men who held out when there was no chance of victory were inflicting useless loss on their opponents, and thus deserved to forfeit their own lives. But nowadays the threat to massacre the heroes of a desperate defense would be regarded as infamous. War in this respect has become more chivalrous. And the whole process or evolution of the "custom" has been in the direction of humanizing war. In the Middle Ages quarter was given to knights and nobles, for they could be held to profitable ransom; but mere common soldiers were freely ridden down, for there was no profit in making them prisoners. Strangely enough, this was the indirect result of a great forward step in the progress of civilization. Soldiers of still earlier times, when slavery was a world-wide institution, were anxious to take hundreds of prisoners, for they could be enslaved, and so were worth money. The abolition of slavery led at first to more slaughter in the rout of a beaten army.

War at the best is a horrible business. Only those who have never seen it have any other opinion. But though the actual means of destruction have grown more deadly, war has become in a great degree humanized, and is not so horrible as it was. The tendency now is to avoid useless killing and mere destruction for its own sake, and quarter is always freely given. Men who have ceased to resist actively are indeed sometimes killed when blood is hot, as when a position is stormed with the bayonet or in the first rush of victorious cavalry; but there is no slaughter in cold blood. Far less is there any idea of the deliberate killing of non-combatants, though if they are within the range of fire they must, of course, take their chance. The wounded are cared for, to whichever side they belong. Plunder and outrage are sternly repressed.

It is easy enough for a logical-minded critic to point out the contradiction of first using the resources of science to disable a man, and then taking even greater trouble to restore him to health. The contradiction disappears when one notes that the object of the soldier who is no longer a bloodthirsty barbarian, but a civilized Christian, is primarily not to kill his enemies, but to break their power of resistance and put them *hors de combat*, or (to use a phrase taken from peace maneuvers) "put them out of action." This is no mere ideal distinction, but happily represents a fact, the outcome of centuries of progress. The Red Indian killed outright and took the scalps of his enemies. More than one Eastern fighting race collected the heads of as many slain foes as possible. The European soldier kills, but the killing is not massacre; it is the result of using deadly weapons to knock out and terrify his opponents. A general does not exult in the number of the dead on the other side. What he aims at is to have crowds of wounded and unwounded prisoners, with as many thousands more of the enemy as possible dispersed, disorganized, cut off from their supplies, and no longer dangerous. Hence killing for the mere sake of killing is avoided.

Even in the heat of battle this is so. After one of our victories in the Sudan an officer, telling me of his personal experiences, said, "I rode in among the Dervishes. They had no fight in them, and were bolting like rabbits. I could easily have shot half a dozen with my pistol; but it's not my business to kill men running, but to lead my battalion." Another officer who now wears the V.C. told how in a cavalry fight the opposing troops met in a cloud of dust, and as it cleared he saw a Dervish horseman, cut off from his friends, riding beside him. "I could have killed him," he said, "but he looked such a sportsman that I let him go." Outposts remain in sight of each other for days without exchanging a shot. Disciplined troops soon realize that killing stray men is of no particular advantage, and firing on the outpost line means disturbance of the rest of the camp or bivouac behind it. It is only uncivilized hillmen of the Indian northwest frontier who keep everyone awake by sniping or sending long-range shots at random into a camp.

Nothing is more unlike the stay-at-home civilian's idea of war than the conduct of opposing outpost lines. Gen. Sir Richard Harrison, in his recently published "Recollections," describes a visit he made to the outposts of the Federal army during the American civil war. The Confederate picket line was well within rifle range, and he was able, after an exchange of friendly signals, to ride across and have a talk with the Southerners. "A hill only was between the combatants," he says; "but they had been fighting too long and too seriously to keep up an incessant conflict between outposts. In fact, they had arrived at the condition experienced by our troops and the French at the end of the Peninsular war. Sentries and vedettes signaled when an advance was imminent from either side; and, unless special orders had been received to the contrary, the outposts retired before the signal without an attempt to shed blood."

Gen. Harrison's reference to the Peninsula reminds us that the records of that war are full of instances of the friendly courtesy of the opposing forces. Men on hostile outpost lines would slip across to ask for a light or buy tobacco from each other. A British officer inspecting the outposts saw an advanced French sentry asleep. Instead of carrying him off a prisoner, he rode over and woke him up, and told him he did not want to see a young fellow get into trouble by being found asleep at his post. In a lull of the fighting at Talavera, French and English soldiers came down to the same stream and drank together.

In the lines outside Metz and Paris during the Franco-German war there was the same tendency for the tacit truce on the outpost lines to lead to irregular fraternization between the opposing forces; but on account of the fear of its being taken advantage of for purposes of espionage, strong measures were adopted to keep Frenchmen and Germans from smoking, drinking, and playing cards together.

When it comes to actual fighting, the custom of war forbids certain effective methods of getting rid of an enemy. One may cut off his water supply, and thus inflict serious suffering on all concerned, and if the deprivation is prolonged produce an outbreak of pestilence; but one must not poison wells, reservoirs, or streams. The rebels in Arabia practised this method against the Turks; and in the war between Japan and China the Japanese in their advance through Corea did not use the village wells, but substituted for them Abyssinian tube wells and other methods of obtaining a reliable supply, because they had been warned that the Chinese might poison the wells—conduct which civilized belligerents regard as utter savagery. The underlying principle of the unwritten code that allows one to cut off the water supply and forbids one to poison it appears to be that a belligerent may take steps that will indirectly cause sickness among the enemy, but must not work directly and intentionally for this end. In earlier centuries the distinction was not made so delicately. A medieval writer on artillery describes how to produce pestilence in a besieged town. His method is to allow the dead bodies of horses and cattle to become corrupt, and then cut them into convenient pieces and shoot them into the town with catapults. One wonders if this plan was ever adopted.

The custom of war—which in this case is to some extent set forth in international conventions—also forbids mere useless maiming and the infliction of avoidable suffering. Thus the use of the explosive rifle bullet is forbidden. In other words, one may inflict a bullet wound that will disable a man, perhaps kill him; but one must not do it in such a way as inevitably to inflict horrible and deadly wounds. On this principle there has followed a tacit understanding among civilized nations not to use soft-nosed, collapsible bullets that "set up" or "mushroom," the kind of bullets now used against big game. This was why during our South African war army orders forbade the use of the dum-dum rifle bullet and of a type of enlarging pistol bullet. But there is a tendency to use these ugly bullets against savage foes. The reason for making this difference is that while the more or less educated civilized soldier, when he is hit even by a small bullet, and the injury is slight, will mostly become nervously anxious to have it attended to at once; while the uneducated barbarian, who has no nerves to worry him, and, as Mr. Kipling puts it, "knows no more of his inside arrangements than an eight-day clock does of its works," is very likely to come on and get to close quarters even after two or three small bullets have gone through him. This is why the soldier, who is handier with the rifle than the bayonet, likes to have a "man-stopping" bullet.

Explosive bullets being forbidden, a lower limit has to be set to the size of projectiles that carry a bursting charge. No shell must weigh less than half a kilogramme—that is, roughly, a pound. Hence the smallest shell used is the little one-inch steel shell for the "pom-pom," fired in sets of ten, that burst like a string of crackers. In South Africa they inflicted few casualties, but they got strangely on men's nerves. Rifle and heavy artillery fire was easier to face than these nasty little projectiles.

One wishes the prohibition against small exploding projectiles could be extended to the grenades filled with high explosives that were introduced by the Japanese in their war with Russia. They were used in storming entrenchments, and were fired from wooden mortars which two men could run up with to the firing point. They produced hideous injuries, blowing away limbs, faces, one side of the body, crippling for life those they did not kill outright. It may not be generally known that our army has practically adopted the idea, and experiments have been made at Woolwich with high explosive grenades and portable mortars. It seems a repulsively cruel method of fighting, though it must be said that ordinary heavy shell fire also inflicts very nasty injuries.

In one respect war has become notably less chivalrous. In the Middle Ages, up to a comparatively late date, there was a disposition to regard battle as a tournament on a large scale. There was an idea that armies should be matched on equal terms on a "fair field." When James IV of Scotland marched across the Border in 1513, and on the approach of Lord Surrey's English army took up a position to await battle "on Flodden Hill, steep on both flanks, and defended in front by the deep river Till," Surrey sent him a letter complaining that "he had put himself into ground more like a fortress or a camp than any indifferent (that is, equal and fair) ground for battle to be tried." A modern general receiving such a letter would think his opponent had lost his wits. By interposing between the Scottish camp and Scotland, Surrey succeeded in luring King James into leaving his vantage ground and attacking, with disastrous results. Nowadays "everything is fair in war" except assassination and treachery.

Spies are hanged or shot if they are detected, not because espionage is a crime in itself, but to make the spy's business more difficult and deter people from taking it up. The essence of espionage is disguise. An officer, if he is in uniform, may venture as far as he likes to go to reconnoiter an enemy. He is not a spy unless he disguises himself. The Japanese in the last war showed themselves past masters in espionage, but they used methods that Western nations would consider unjustifiable. They employed natives of Corea and Manchuria to act as spies in the Russian lines, and, if report speaks truly, these agents ran a double risk. If the Russians detected them they were hanged; if they came back without satisfactory information, they might be shot by their employers "to encourage the others." Our Eastern allies still keep to a very grim kind of custom of war. Rumor says that at the naval battle of Tsu-shima hopelessly wounded men were quietly dropped overboard to clear the decks and save unnecessary trouble.

Connected with the custom as to spies are the written or unwritten laws that forbid the people of the country from taking an active part in its defence unless they have at least some plain badge to show they are combatants. The whole legislation as to the patriotic action of civilians is a little confused. The German military law orders that in case of invasion the levy *en masse*, or Landsturm, is to be called out, and the armed inhabitants who thus come into action need not have uniforms; yet the Prussians used to shoot captured *franc tireurs* in France on the ground that they were irregular combatants, without recognized uniform or commissioned officers. It is generally recognized that the people of a town may fight in its defense without uniforms, for in a siege all the people within the fortifications are presumably enemies of the besieger.

The Hague Convention recognizes the right of the civilians of an invaded district not yet effectively subdued by the invader to fight in its defense even if they are not uniformed. Thus the execution of Mr. Brown for defending his home, in the play known as "An Englishman's Home," is an episode based on ignorance of current military usage, though the author of the play is a soldier.

The use and abuse of the white flag of truce is, again, a subject of much discussion. There probably has been no war in recent years in which each side did not charge the other with treacherous misuse of this flag. Sometimes the origin of such charges is clearly that—as in the case of our own men in the surrender at Nicholson's Nek—while some are ready to surrender and show the white flag, others are anxious to fight on and continue firing. It may not be generally known that the recognized custom of war allows troops in certain cases to fire on the bearer of a white flag. To display the flag means that one wants to communicate. If the other side is willing to do so they cease firing, stop their advance, and signal to the white-flag bearer to come forward. But they are also free to refuse to communicate. In this case they may signal a refusal and continue advancing and firing. If the bearer of the white flag persists in coming on he may be shot down. The reason for this is that if the mere display of a white flag necessarily stopped the fighting it might be used at a critical moment to delay temporarily the advance of the attack on an important point. But the right of refusing to let the white flag come forward is very rarely used.

The most satisfactory development of the custom of war is the legislation as to the Red Cross embodied in the Geneva Conventions. Its effect is to neutralize and give as much security as possible to all that is connected with the care of the sick and wounded. The change does not affect only the actual battlefield. In the American civil war the Federals treated quinine as contraband when the Confederate hospitals were sorely stricken for the want of it. Now the cases marked with the Red Cross would be passed through the outpost lines. The Red Cross flag, the most honored standard displayed in war, is really the flag of Switzerland, with the colors reversed. The Swiss flag is a white cross on a red ground, the ambulance flag makes the ground white and the cross red; and Switzerland has the further honor that the legislation for the care of the wounded was drawn up in a Swiss city. Thus it was not without reason that a Swiss orator once said: "Our flag does not fly as the standard of conquering and devastating armies, but it is a flag of ours that is carried into the midst of the misery and ruin of war all the world over, and has already been displayed on a hundred battlefields as the symbol, not of war and death, but of life, mercy, and charity."—Chambers's Journal.

Chinese wood oil, which is fast becoming one of the staple market products of central China, and of which considerable quantities are shipped from Hankow, is obtained by cold pressure from the nuts of the tung tree, which grows extensively in the Yangtse Valley. Recently it has been used to some extent in the manufacture of varnishes of various descriptions. Its peculiar property of drying flat, with a surface very similar to that shown by ground glass, has up to the present time prevented its use to any great extent in the manufacture of paint. Alone or with pigments, it dries with a dead appearance, and even when used in a small proportion with other oils and varnish it tends to cause a "flatting" and sometimes crinkling surface to whatever it may be applied. The former property has been utilized to produce varnishes in which wax was formerly used as an ingredient. China wood oil has other peculiarities which render it vastly different from all other drying oils. The odor is very characteristic and stubbornly resists destruction, regardless of the manner in which the oil is treated. This admits of its identification when present in but small proportions in varnishes, etc., regardless of other constituents. Another very interesting property is the instant change into a jelly-like substance when heated to 300 deg. C. The material this produces is insoluble in all ordinary solvents, and cannot be melted by further heating. The properties of this oil which have brought it into extensive use are several. The oil may be heated without discoloration. It can be treated so as to remove the tendency to "flat," and then produces varnishes with a fine gloss. It has the property of drying hard, but tough, and when used with rosin will produce better results than when mixed with linseed oil. Its use has made it possible to produce a number of good varnishes at a very low cost. The best grade of China wood oil is thicker than linseed oil, with the specific gravity of 0.994 at 15 deg. C. and flashing point at 280 deg. C. When applied to a flat surface the drying appears to take place throughout the entire body of the oil at one time, instead of from the top down, as is the case with many other oils. When heated to about 260 deg. C. with pure manganese borate the oil, if pure, is not discolored.—Daily Consular and Trade Reports.

FILTERS FOR ULTRA-MICROSCOPICAL PARTICLES.

DIFFERENT processes are used for purifying alimentary and industrial liquids. The most effective and economical of these at first sight would seem to be sterilization by heating. Recent researches have, however, shown that, apart from the evident loss of flavor, both the digestive and nutritive properties of liquids thus treated are greatly impaired. Furthermore, filtration cannot be dispensed with even after sterilization, simply to get rid of foreign matter causing turbidity.

Efficient filtration would doubtless be more advantageous. However, filtration devices (designed on the principle of the Chamberland candle) which are at present in use, are defective in many respects. In fact, the filters keep back the minute particles by molecular adhesion on the filter walls, rather than by the narrowness of their filter channels, so that the microbes contained in the liquid, after some time (in some cases after from three to four hours) begin to pass through, either by virtue of their multiplication in the interior of the filtering channels, or by virtue of their lively motion, which eventually carries them beyond the range of capillary action. Furthermore, these filtering candles allow viscous liquids to pass only slowly.

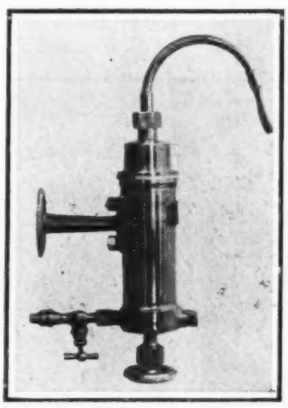


FIG. 1.—THE DOMESTIC APPARATUS.

Dr. Bechhold of Frankfort-on-the-Main some time ago suggested a new principle of filter construction, which consists in passing the liquid through a gelatine layer. More recently two French engineers, Messrs. E. Gobbi and E. H. Taine, have carried out successfully another system of construction recorded in a communication to the French Academy.

The two inventors have endeavored, primarily, to solve the problem of avoiding any rapid obstruction of the filter, while making the filtering process both cheaper and safer.

They discarded all porous substances, either of mineral or vegetable origin, using only unalterable, resisting and comparatively cheap materials. The apparatus was, finally, to be so designed as to be always got into working condition merely by washing, without being unmounted, and to lend itself to the filtering of the most widely different liquids.

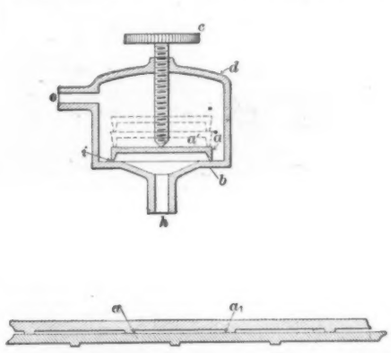


FIG. 2.—SECTIONAL VIEW OF THE GOBBITAINE ULTRA-MICROSCOPIC FILTER.

The filters submitted to the Academy are mainly based on the narrowness of the channels, the microbes being definitely and not temporarily arrested by the extreme smallness of the interstices. Capillary attraction is reduced by making the filtering interstices shorter and more regular, so as to allow of the integral passage of toxines, diastases, and other viscous liquids. These filters thus arrest, during some hours—even for the space of a day—the colloidal grains of dyeing substances and are maintained indefinitely sterile.

The filters consist of a nickel tape 1/10 millimeter in thickness and 1½ millimeters in width (length of the filter patch). This tape, some hundreds of meters in length, is wound helicoidally on its broad side, the various spirals being forced against one another by means of a screw, so as to constitute a compact cylinder.

This cylinder could be rendered impervious by straining the screw, but for a series of minute transverse ridges projecting from one of the faces of the tape at very short distances from one another. In this manner are obtained very regular interstices of the dimensions most convenient for the industrial or scientific application at issue. The protuberances and accordingly the interstices can, for instance, be reduced to dimensions smaller than those of the most minute microbes, while the width of the tape can also be reduced with a view to diminishing the friction of the liquid.

The remarkable smallness of the interstices of this filter (which, by the way, could be made of even smaller dimensions) allows not only the microbes, as in the case of ordinary filters, but even the grains of colloids, which are far smaller than the former, to be arrested, and justifies the name of "ultra-microscopical" filter.

RECLAIMING MESOPOTAMIA.

AN important report has been presented to the Turkish government by Sir William Willcocks, the eminent English irrigation engineer, respecting the ways and means of reclaiming the territory of Mesopotamia, and restoring this country to its former prosperity. Some months ago, upon the reconstruction of the Ottoman Constitution, Sir William Willcocks was requested by the Turkish authorities to proceed from Egypt, in the irrigation schemes of which country he has carried out a prominent part, to the country of the Tigris and Euphrates to elaborate a scheme for restoring the irrigation system which formerly existed centuries ago, and which had fallen into desuetude.

As a result of his investigations in the Delta of these two rivers, the engineer has suggested irrigation works to the value of about $9,500,000, divided approximately equally between the two waterways. He advocates the erection of barrages on the Hindieh Canal and on the Habbania and Sakhlawia, as well as improving the navigation of the Tigris. As a result of these works it would be possible to restore 247,110,000 acres, out of the total area of 1,235,550,000 acres, comprising the Tigris-Euphrates Delta, to their former prosperity, and the works would occupy about eight years to complete.

In addition to these irrigation works, the engineer strongly advocates railroad communication between the Delta and the Mediterranean, to facilitate transportation between the two points, and to provide a convenient channel to Europe for the produce of the country. He suggests a railroad of 3½ feet gage from Baghdad to Damascus, effecting a junction with the Hedjaz railway, and reaching the sea at Haifa, the present tidewater terminal of the sacred railway to Mecca. Such a line would be about 500 miles in length and its cost would average about $13,500 per mile, while it could be completed in about two years. Such a line, he points out, would be the main artery of traffic in all produce raised in the most eastern Turkish territory in Asia and also of Persia, while in the opposite direction would be conveyed the bulk of the import traffic. He also points out that it would afford easy access for American and European tourists and travelers to the ancient districts of Baalbec, the Garden of Eden, Chaldea, Babylon, etc., which at present are so difficult to reach. This traffic alone, he maintains, would be considerable. In addition, by forming a junction with the Holy railway at Damascus, there would be a considerable Mahommedan traffic in connection with the pilgrimage of the East Asian Mahommedans to the sacred cities of Islam. He opines that such a railway would give an annual profit of $496,000 per annum before the proposed irrigation works were completed, which revenue would be very appreciably augmented as the Tigris-Euphrates Delta was reclaimed.

These important schemes are being carefully considered by the Ottoman government, and Sir William Willcocks was recently in England in connection with construction and materials for the irrigation works which are to be undertaken at once. An English syndicate has already offered, in conjunction with Turkish capital, to construct the railway, upon which, however, no definite official decision has yet been pronounced, though it is anticipated that the works will be carried out in the near future. The navigation of the Tigris, which is at present an English monopoly, has recently been strengthened by the introduction of Ottoman interests, and it is expected that there will ensue a wave of revived prosperity in the lands so famous in Biblical history. Certainly this territory is the most fruitful in the whole of the Ottoman Empire if its reclamation is carried out upon such broad, comprehensive lines as are advocated by the well known English engineer, who has since arrived in Constantinople in connection therewith.

A NEW AUTOMOBILE BOAT.

AN AMPHIBIOUS CRAFT.

BY WALTER ROGERS.

A FRENCH inventor, J. Ravailler, has devised a self-propelling vehicle which can navigate the water like an ordinary motor boat and also travel overland like an automobile. The official tests of the boat, recently made in the presence of M. Barthou, the Minister of Public Works, and other distinguished persons, were crowned with complete success. To tourists who make use of this amphibious vehicle canals, rivers, and lakes will present no serious difficulties, as they can be crossed with ease and comfort wherever moderately gentle and smooth slopes, natural or artificial, can be found for entering and leaving the water.

By courtesy of Illustrated London News.

OFFICIALLY ADOPTED BY THE FRENCH WAR OFFICE: THE "CANOT-AUTOMOBILE" RAVAILLER LEAVING THE ROAD AND TAKING TO THE WATER.

It cannot be said that an amphibious automobile is altogether a new idea; but a "canot-automobile" invented by M. Ravailler, the engineer, is the first vehicle of its kind to be officially adopted by any government for military or other purposes. It is believed that the machine, which has been handed over to the first regiment of engineers, at Versailles, by the French War Office, will be of great value in scouting, and in various other ways—for instance, for taking a line across a stream so that a temporary rope "bridge," like that made possible by the rocket apparatus, may be fixed. The car has a 14-horse-power engine; can surmount grades of 15 per cent; has a road speed of about 35 kilometers an hour, and a speed afloat of about 9 kilometers an hour. The transmission of the driving power from the wheels to the propeller, and vice versa, is as quick as it is simple.

The hull of the boat, which is made of steel plates riveted to steel ribs of T-shaped section, is mounted by means of springs on axles and wheels of pressed steel. The axles pass through water-tight tubes which traverse the hull. This part of the construction, which is very cleverly designed, is the invention of M. Gustave Pitre, the naval architect of the Maisons Laffitte.

The motor (constructed by Gontalier, of Vincennes) is placed near the bow. It drives, by means of a clutch of the disk type, two distinct systems of mechanism: 1. A variable speed shaft transmits the power to the rear or driving wheels by means of chains and pinions, the arbors of which pass through stuffing boxes. Three forward speeds and one backward speed are provided. Coupling, retarding and speed-changing levers, a differential brake worked by a pedal, and a brake lever acting on the rear wheels complete the mechanism of propulsion on land. Steering is effected, as in an ordinary automobile, by a wheel passing through a stuffing box. 2. The variable speed driving shaft, prolonged backward beyond the rear axle, may be connected, by means of a clutch, with a screw propeller at the stern of the boat, the connection being made by moving a lever placed at the left hand of the driver of the vehicle. The rudder and the front axle are turned by the same steering wheel.

The capstan, which is seen at the bow of the boat, is turned by a tangent screw which is driven by the motor, by means of a wheel and belt, and connected and disconnected by a loose wheel, or idler.

The driving wheels, the propeller, and the capstan can be operated separately or simultaneously.

The speed of the vehicle, as determined by numerous trials, is 35 kilometers (21¾ miles) per hour on land and 9 kilometers (5.6 miles) per hour in the water.

The boat enters and leaves the water without any preparation or change, except in mechanical connections. When afloat its stability is perfect, as is shown by one of the illustrations. It leaves the water and climbs the bank under the impulsion of its driving wheels if the ground is reasonably firm and the grade less than 15 per cent. If the bank is steeper or softer, a rope is fastened to a stake driven into the ground, and the boat is hauled up by the capstan.

The equipment of the boat is completed by a pump for bailing, an anchor, a buoy, and a pair of oars and movable rowlocks for use in case of accident to the motor while afloat.

The Ravailler automobile boat seems destined to render valuable services to tourists. The best proof of the practical value of this invention is the fact that it has been purchased, together with all its patents, by an American.

A BINOCULAR FALLACY.

WE have been struck of late by the persistence with which the old myth with regard to the combination of colors by binocular vision holds its ground. Long ago it was demolished by Du Tour and by Wheatstone, but it is now revived, and actually made to serve as the basis of methods of producing stereoscopic photographs in natural colors. The ignorance which prevails on the subject is evidenced by the fact that in one projected process the colors are assumed to combine additively, while in another they have to combine on subtractive principles. Both cannot be right, while it is quite clear to anyone who has experimented with the binocular combination of colors that actually both are wrong. The result is not a mixture of the two colors, but confusion. If, for example, one image is red and the other blue, in a stereoscopic slide we may intermittently see a violet image, but in between whiles we shall see alternating blue and red images. If, as an alternative experiment, we view a white object through blue and red glasses, we get very similarly changing effects, with the difference that the colors are so feeble as to look almost like neutral tints. One explanation of these variable phenomena is that the eyes always see alternately. This was advanced by Du Tour and a few others, but it is hardly a proved fact. Another suggestion is that the changes are due to non-coincident after-images, but this again is hardly feasible. Possibly the simplest and truest explanation is that our eyes are not constructed for the purpose of combining colors in this fashion. We know that if red and blue together strike one retinal unit in the eye, we get the sensation of violet; but there is no warrant for assuming that when red meets one retinal unit in the eye, and blue a corresponding unit in the other, we shall again get a sensation of violet.

Theory has not a scrap of evidence to suggest that we should do so, while practice proves that we only do so occasionally and by a kind of a fluke. The neglect of both theory and practice must surely be responsible for these suggested color processes. It is interesting to note that we meet with a similar visual breakdown when we try to combine two quite dissimilar monochrome images. Even when they are simple regular line patterns, we do not see the two combined to form a more complex regular pattern. All we see is sometimes one pattern, and sometimes the other, while these appearances alternate with glimpses of what appear to be broken bits of each pattern. Wheatstone attempted an explanation which practically amounts to suggesting that the brain is inattentive to intelligence sent to it through the eyes when the two eyes simultaneously tell quite different tales. When we meet with two witnesses who spin quite different yarns, and both talk at the same time, the only thing to be done is to separate them, and make each tell his tale by himself, and it is quite reasonable to assume that this is what the brain does when its scouts, the eyes, contradict one another. It then studies the subject through the medium of each eye alternately until some general idea is obtained.—The British Journal of Photography.

According to the Electrical Review (London), the Admiralty have decided to erect a wireless telegraph station at Wick. An acre of ground has been leased, and provision will be made for a staff of twelve men. The station is to be equipped with the latest appliances for long-distance communication, and is expected to be in working order early next year. It is reported that the airship "Zeppelin III." has been proved capable of communicating by wireless telegraphy with stations at a distance of 300 miles. Nevertheless, the experts consider that, to insure successful communication, wood must be substituted for aluminium in the construction of the frames of airships of the rigid type.

THE NON-MAGNETIC SHIP "CARNEGIE."*

A VESSEL WITHOUT IRON OR STEEL.

BY E. A. DIXIE.

NEVER since the Bronze Age (and probably not even then) until the building of the "Carnegie" has a vessel of this size been made without wrought iron or mild steel in her construction and equipment.

Her displacement is about 600 tons and there is no wrought iron or mild steel, and less than one pound of cast iron, in her construction for each ton displacement.

THE ENDOWMENT OF THE CARNEGIE INSTITUTION.

January 28th, 1902, Andrew Carnegie gave to a board of trustees $10,000,000 in registered bonds, yielding 5 per cent annual interest. On December 10th, 1907, he added $2,000,000 to this. With this endowment the institution was originally organized as the Carnegie Institution. Later it was incorporated by an act of Congress, approved April 28th, 1904, under the title Carnegie Institution of Washington.

OBJECT OF THE INSTITUTION.

The object of the institution is the promotion of investigation "in the broadest and most liberal manner." Many projects in widely different fields of inquiry have been considered or are under consideration. Among these is the department of terrestrial magnetism, founded April 1st, 1904, of which Dr. L. A. Bauer, The Ontario, Washington, D. C., is in charge.

For the pursuit of the investigation of terrestrial magnetism the "Carnegie" has been built.

A TRIAL MADE WITH A PARTIALLY NON-MAGNETIC SHIP.

The first vessel used for survey purposes was the "Galilee," a vessel which was chartered and adapted as well as conditions would permit.

She made a general magnetic survey of the Pacific extending from the Aleutian islands on the north to New Zealand on the south, Asia on the west and the Americas on the east. Her cruises aggregated 60,000 miles and extended from August 1st, 1905, to June 1st, 1908.

Owing to the fact that iron and steel, both magnetic metals, enter largely into the construction of ships, sensitive magnetic instruments are liable to the influences of such iron and steel parts, and accurate readings of such instruments are not possible where such local attraction exists. The "Galilee" was stripped of magnetic fittings wherever possible, but it was obviously impossible to remove all iron and steel from a vessel already built and built without the knowledge that she would some day be devoted to this magnetic research work. The results obtained with her were, however, so unsatisfactory (errors of 4 to 5 degrees being found in charts) that it was decided to build a vessel as nearly not magnetic as possible, and this decision resulted in the launching of the "Carnegie" on the 12th of June, 1909, her keel having been laid in the middle of February, 1909.

WHY THE COMPASS DOES NOT ALWAYS POINT NORTH.

It is now well known that the compass or magnetic needle points true north and south at but few places on the earth. In all other places it points either east or west of true north.

In the United States there is a long narrow belt, running approximately through Columbus, Ohio, and Columbia, South Carolina, where the north end of the compass at present points either exactly or nearly true north. I use the term "at present" because the magnetic pole is not fixed in position, but is at present apparently moving westward. This change is called "secular variation" and amounts to as much as ten degrees or more in a century.

To give an idea of the variation of the compass in the United States from Maine on the east to Washington on the west, it would be found that north as indicated by the compass would vary from 20 degrees west of north to 24 degrees east of north in these two States respectively.

THOSE DIRECTLY INTERESTED AND WHY.

The mariner, the surveyor and the explorer rely upon the compass or magnetic needle to guide and serve them for their purposes. They must hence have charts showing how the compass points at all parts of the globe and by what amount it changes from year to year. In the existing charts of the oceans the latitudes and longitudes, the depths, the directions and speeds of currents and variations of the compass, etc., are put down for the mariner's guidance. The variations as set down in these charts are known to be incorrect, and the supplying of true magnetic charts and compass data is one of the chief objects of the magnetic survey and incidentally of the "Carnegie."

If one were to start from New York city with a compass in hand and follow the direction pointed by the north end of the needle he would be led across Lake Ontario into Canada, along the east side of James Bay across Hudson Bay in the direction of Boothia Felix in Arctic North America, where the north magnetic pole seems at present to be situated. As he approaches this point the needle would become more and more fickle and less and less inclined to point in a definite direction. Right at, or above, the magnetic pole it would point in any direction and would be no more use for telling direction than a ham sandwich.

ANOTHER INSTRUMENT USED BY MAGNETICIANS.

Thus we see, the force exerted by the earth as a magnet upon the compass becomes less and less as the

THE NON-MAGNETIC SURVEY YACHT "CARNEGIE."

* By courtesy of the American Machinist.

magnetic pole is approached and at this point its influence while still extant is, because of apparent lack of direction, of no value to the observer. However, the magnetician is fortunately not dependent upon the compass alone; he has another instrument, the dip circle or dip needle, as it is commonly called. This is practically a compass needle hung on a horizontal instead of a vertical axis; the needle is thus capable of swinging freely in a vertical plane. The needle of the dip circle would at the magnetic poles stand exactly vertical.

Thus we see why the compass needle becomes so erratic at the magnetic poles, because the magnetic force or pull is at this point in a vertical direction.

THE MAGNETIC EQUATOR.

Half way between the magnetic poles there is a line similar to the geographic equator but not coincident with it called the magnetic equator. The magnetic equator intersects the geographic equator at various points, and here the dip needle would lie precisely horizontal.

OFFSETTING THE INFLUENCE OF "DIP."

As the compass approaches the magnetic poles the vertical "pull" referred to has the tendency to pull or dip the compass needle the same as it does the dip needle. This force acting on the compass needle is overcome by a small adjustable weight attached to the opposite arm of the needle. Thus, in the north magnetic hemisphere the weight would be on the south pole of the compass needle. How much the needle dips at various parts of the earth and the amount of dip and the change in dip from time to time will be another task for the magnetic survey to determine.

I might fill this issue of the American Machinist from cover to cover telling the various known problems which it is intended that the magnetic survey shall solve and then the story would be but partly told, for in all research work discovery leads on in an endless chain to other discoveries. One peculiar fact is known about the magnetic poles: they are not antipodal to each other and a straight line connecting them would miss the center of the earth by about 750 miles or about one-fifth of the earth's radius. This gives a reason for the very irregular distribution of magnetism throughout the earth.

THE EARTH A GIGANTIC MAGNET.

The earth is thus shown to be a gigantic magnet and is capable the same as other magnets of communicating magnetism to other magnetizable bodies on its surface. Previous to the advent of iron and steel in ships this phenomenon did not make itself particularly obnoxious, but since these metals have become the principal ones used in naval construction it has been found that if an iron ship is built on stocks running north and south, it becomes a permanent magnet and its influence on the compasses used by its navigators render them if not useless at least unreliable. The "setting" of the magnetism in the ship is also aided by the vibration due to the setting up of the rivets with hand and pneumatic hammers. For this reason, all ship yards or at least all stocks for metal ships are built approximately east and west. This same peculiar tendency to become permanent magnets is noticeable to a marked degree in steel and iron ships taking long voyages in a generally northerly or southerly direction. In any case, no matter what direction an iron vessel sails the magnetism of the ship is forever changing.

THE NON-MAGNETIC VESSEL.

The "Carnegie" combines the seaworthy qualities of an ocean-going vessel with the neat trim appearance and comforts of a private yacht.

Her hull was designed by Henry J. Gielow, engineer and naval architect, 52 Broadway, New York, who is himself an amateur scientist of no mean ability. Thus the designing of her called from him not only his best effort as a designer of ships but the interest and enthusiasm of the scientific devotee.

THE BUILDER OF THE "CARNEGIE'S" ENGINE.

The engine was designed and is being built by James Craig, Jr., 556 West Thirty-fourth Street, New York, who designed and built the internal combustion engines for the submarine boats "Octopus," "Cuttlefish," etc., and except for necessary variations caused by the use of producer-gas instead of gasoline and the use of non-magnetic metal, is the same as the engines installed in the submarines.

THE BUILDER OF THE "CARNEGIE."

The "Carnegie" was built at the foot of Twenty-third Street, Brooklyn, under the supervision of Wallace Downey, vice-president and manager of the Tebo Yacht Basin Company, by William H. Payne, constructor. In passing I may mention that the famous yacht "Meteor" built for the Emperor of Germany and the three-masted schooner yacht "Atlantic" built for Wilson Marshall, of Bridgeport, Conn., and which won the Emperor of Germany's gold medal in the international transatlantic race in 1905, were both built by these two men.

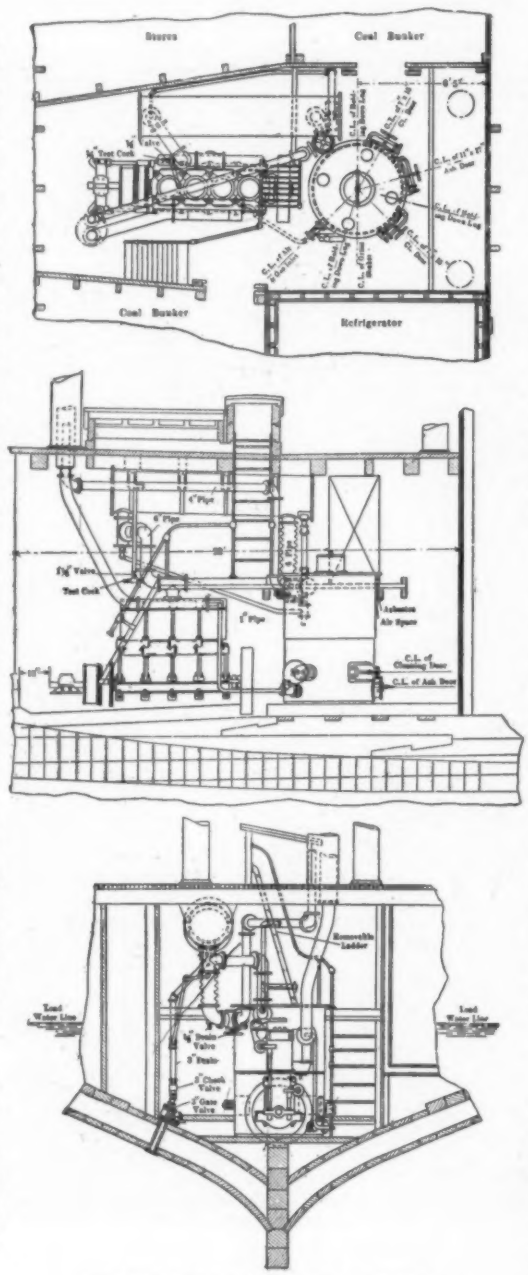
RESTRICTIONS PLACED ON THE MATERIALS.

Owing to the stringent restrictions placed on the admission of magnetic material into the construction of this vessel, a very sensitive instrument was installed at the yard to test all metals entering into her construction. To give an idea how sensitive this instrument is: if you were to take an ordinary pocket knife and hold it 8 feet away from the instrument and then merely turn it end for end, the indicator of the instrument would wag five or six degrees.

The hull of the "Carnegie" is of wood which is fastened together with "tree nails" (which are wooden spikes driven into bored holes; these tree nails are usually made of locust wood) and bolts and spikes of non-magnetic bronze. Where thin wood and canvas are to be fastened, copper and bronze nails and tacks are used. Every bolt, spike and nail has been tested for magnetism, and it is a noteworthy fact that out of the many thousands of metal fastenings used, but seven spikes have failed to pass inspection.

HER DIMENSIONS.

The "Carnegie" is 155 feet 6 inches over all, 33 feet beam, has a depth of hold 12 feet 9 inches and a mean



PRODUCER PLANT AND ENGINE.

draft of 12 feet 7 inches. With all stores and equipment on board, her displacement is 568 tons.

The keel, stem, stern post, frames and deadwood are of white oak grown, cut and sawed at Jamaica Plains, Greater New York, within twelve miles of the ship yard where she was built.

The deck beams, planking and ceiling are of yellow pine, and the deck is of Oregon pine in long lengths. The keel is 12 x 18 inches, and to this is fitted a false keel 12 x 4 inches.

HER RIG.

She is brigantine rig (what this means can be seen by referring to Fig. 1) and spreads 12,900 square feet of plain sail. From the foremast truck (the top of the front mast) to the water surface is 122 feet, and from the forward end of the bowsprit to the after end of the main boom is 201 feet.

The rigging is of Russian hemp, of special make.

It was decided to install auxiliary propulsion in the "Carnegie" so as to provide headway when taking off-shore observations, where the vessel could be with difficulty handled by the sails and to prevent interruptions in the observations by maintaining headway during calms.

WHY A PRODUCER-GAS ENGINE WAS CHOSEN.

The necessity of providing means of propulsion which would be nearly non-magnetic in character made the type of plant somewhat difficult of selection.

The only type of prime mover which could be built at a reasonable price and maintained in reliable operation with a minimum amount of non-magnetic metal in its construction appeared to be an internal-combustion engine.

Consideration of the available fuel for such a motor resulted in the elimination of gasoline or oil, not only on account of cost, but also because it would be impossible to procure them in the zone to be covered by the "Carnegie" as well as being dangerous in the quantities which would have to be stored for the lengthy voyages which are contemplated. It is well known that many thousands of horse-power are being developed with internal-combustion engines on land using gas generated from solid fuel. A careful investigation showed that a gas producer for marine purposes could be built which would generate producer gas for use in internal-combustion engines from bituminous or anthracite coal, coke, wood, or charcoal, and that such a plant could be constructed almost entirely of non-magnetic materials. The suction type of gas producer was adopted principally for the reason of its simplicity in construction and operation, and the elimination to a minimum degree of other auxiliary apparatus.

POWER PLANT AND CRUISING RADIUS.

The "Carnegie" is equipped with a four-cylinder Craig internal-combustion engine of 150 horse power, shown in Figs. 2 and 3. The gas producer, shown in Fig. 4, is furnished by the Marine Producer Gas Power Company, of New York, and consists of a cylinder 6 feet high with a diameter of 5 feet 6 inches built of copper with asbestos and firebrick lining and manganese-steel grates. Anthracite coal will be used as fuel, the gas to be generated in the producer and taken to a special scrubber of copper from which it passes to the internal-combustion engine. The vessel will carry 25 tons of coal in her bunkers which will give her a cruising radius of 2,000 nautical miles at six knots.

EQUIPMENT.

The ground tackle comprises four bronze anchors of special design. Two anchors of 1,900 pounds each, one of 13,335 and a kedge anchor of 340 pounds; three 11-inch hemp cables, each 127 fathoms in length are required for these anchors, as no satisfactory non-magnetic chain was obtainable. The hawser pipes are of bronze of special design and the boat davits and all metal deck fittings and chain plates are of special bronze. The boat equipment consists of two non-magnetic gigs. A refrigerating plant constructed of bronze and copper operated by a six-horse-power special engine forms a necessary part of the equipment for a vessel which at times will be a month or more continuously at sea. All living quarters are below, the sailing officers' and crew's quarters being forward, after which are the quarters for the scientific staff mentioned in the machinery space. The living quarters are especially planned with a view to giving good accommodations for all. There will be two galleys, one for the scientific party and the other forward for the crew. Specially designed cooking ranges of bronze and copper have been provided.

WHERE THE OBSERVATIONS WILL BE TAKEN.

Of special interest is the observation room located on the main deck amidship, forward and aft of which are circular observatories with revolving domes, not unlike those of astronomical observatories. It will thus be possible to take magnetic observations both in the open and under shelter inside these observatories. The positions of the stands for the various instruments have been so chosen that any effect resulting from the amount of iron in the machinery (about 500 pounds 30 feet from the instruments), which could not be replaced by non-magnetic material, would be so small as to be negligible. With regard to the engine itself, the cylinder castings which are usually made of cast iron have been made of special bell metal composed of 80 per cent copper and 20 per cent tin. This metal is so hard that it took seven cuts to finish a cylinder. It has been found that the gas carried over from the producer plant sometimes contains sulphuric acid, but this metal will resist its action. The balance of the engine is of special bronze. Owing to the weakness of producer gas the compression space in the engine has been altered. With the ordinary run of gasoline engines the compression is about 75 pounds per square inch; with the producer gas it is necessary to almost double this. For the same reason given above, the valves and induction pipes have been increased to twice the area of valves and induction pipes used in gasoline engines. A special sparking device must also be used, as the ignition for producer gas must be most pronounced.

MAGNETIC METAL USED.

The only parts of magnetic metal used in the engine are the pistons and piston rings which are made of

cast iron. Nickel steel is used for the cams and valves. When the question of making the pistons first came up bronze was suggested, but as this is so brittle at high temperatures it was not considered available. The next metal suggested was manganese steel, but this is very difficult to cast, and the makers said that they might cast as many as twelve pistons without getting a good one. Another great difficulty with manganese steel is machining it. It cannot be finished with anything but an abrasive wheel.

PECULIAR FACTS ABOUT NICKEL STEEL.

Mr. Craig then suggested nickel steel and wrote to the Bethlehem Steel Company, one of the makers of this metal. They told him that a 25 per cent nickel steel would be practically non-magnetic, and he submitted this information to the Carnegie Institution at Washington. They informed Mr. Craig that while it was true that 25 per cent nickel steel was not magnetic, if it were allowed to reach as low a temperature as 30 deg. F. it would become magnetic and retain it until it was heated to a temperature of about 1,100 deg. F.

Sheath knives of sailors are, as a rule, made of carbon steel, but for the sailors of the "Carnegie," special knives of manganese steel have been made which are practically non-magnetic. If a piece of soft iron is rated as 100, a piece of manganese steel would show only about 1 per cent of magnetic attraction. What will be done regarding the material for the carpenter's tools has not yet been settled.

THE DIFFERENT PHASES OF MATTER.

IN an article published in the Revue Generale des Sciences, M. C. E. Guillaume, of the International Bureau of Weights and Measures, has reviewed the recent work on the different states of matter. Just as Andrews proved that there was no real discontinuity between the liquid and gaseous states, MM. Tamman, Spring, and others have shown that there is not necessarily a discontinuity between the solid and liquid phases of a body. Experiment shows, for instance, that an amorphous solid has no definite melting-point, though a crystalline solid has. Solid water has commonly a crystalline structure, but by cooling it to —60 deg., and at the same time submitting it to a pressure of 2,000 to 3,000 atmospheres, Tamman found that the ice was converted into a new variety of solid water, denser than ice, which would apparently be the stable form even at 0 deg. under a pressure of 10,000 atmospheres. Kahlbaum, again submitting samples of ordinary metals to a hydrostatic pressure, which in some cases was as much as 20,000 atmospheres, found that these samples were converted into a solid less dense at ordinary pressures than the ordinary form. The specimens generally altered also in shape, shortening or lengthening as the case might be, and their surfaces lost their polish. Other experiments in wire-drawing made by Spring confirmed these results. In general, wire-drawn metals proved less dense than normal samples. Bismuth, however, proved an exception, its density being augmented. Generally this metal is extremely weak and brittle, but when "extruded" as a wire through a small orifice, by great pressure, the wire proved quite flexible, and could be tied into a knot without the slightest tendency to break. M. Guillaume remarks that these experiments lead to the conclusion that all solids under heavy pressures tend to be converted into an amorphous state, which has no discontinuity with the liquid and gaseous phases. At the pressures met with a few miles below the surface of the earth the rocks or other material are at once fluid, and yet as rigid as steel. They will flow under the slightest lack of symmetry in the forces acting on them, though their viscosity is of course enormous, and hence enormous lapses of time are necessary for large movements. He suggests that the conditions met with in the interior of the globe may suffice to account for the production of radio-active elements by a process of synthesis. If the enormous pressure obtaining in the interior of the globe is the cause of the formation of uranium, then the radio-activity of the latter is merely a restitution of a small portion of the energy liberated on the condensation of our globe. The fact that pressures of 2,000 atmospheres have been found to have no apparent influence on the radio-activity of radium does not, in his view, provide a conclusive argument against the hypothesis advanced, since this pressure is small relatively to those existing in the interior of the earth.—Engineering.

COLOR ACTION OF METALS IN ALLOYS.

LEAD deepens the color of copper alloys. It is largely used to assist the copper in red metals and also to give gun metal a more coppery appearance than the actual copper content alone would produce.

Zinc improves the casting qualities of copper alloys, but has quite the opposite effect on the color that lead has.

Aluminium gives a mottled surface due to crystallization of that element. One per cent added to yellow brass produces a good imitation of pale gold.

Phosphorus, by closing the grain, allows of a higher polish on all alloys.

Arsenic has a similar effect, but it is now only used for speculum.

Bismuth and manganese produce rose-tinted effects and improve the luster. Bismuth has a powerful effect on all the white-colored metals, giving a warm tone to German silver alloys containing zinc, tin or aluminium.

Antimony has a similar result as regards color, but it is a dangerous element in alloys requiring strength. The cohesive force of antimony is poor.

Copper added to white alloys gives increased luster, greater ease in tooling and better casting qualities.

Mercury, about 1 to 1.5 per cent added to the standard ordnance bronze, copper 90, tin 10, produces a beautiful rose pink tinted metal which makes fine contrasts with other gun metal, brass or silveroid castings. Great care must be exercised in adding the mercury to the barely molten tin intended for the bronze mixture.

Venus metal, an alloy of equal parts of copper and antimony, is a beautiful violet-colored alloy which polishes well but is too brittle for delicate parts of a design.

An alloy used for objects of art and which resembles fine gold consists of copper, 92 parts; aluminium, 6 parts; gold, 2 parts.—J. F. Buchanan, in The Foundry.

ELECTRIC WIRES OF ALUMINIUM.

HITHERTO copper has been employed exclusively for electric wires, whether aerial, underground or submarine, because of its great conductivity, which surpasses that of any other metal except silver. Within recent years the price of aluminium has fallen so low that it may be advantageous to substitute it for copper in many cases. Aluminium wire now costs only 44 cents per pound; owing to the large stock accumulated and the establishment of new and extensive producing plants, since 1905, no increase of price is to be feared. The properties of copper and aluminium are compared in the following table:

	Hard Copper.	Aluminium.
Density	8.9	2.7
Coefficient of expansion by heat	0.0000165	0.000023
Maximum tensile strength in tons per square inch	27 to 31	13 to 14
Limit of elasticity in percentage of tensile strength	40 to 50	35 to 60
Elongation per cent	2 to 3.5	4.5
Ohmic resistance of a wire one meter long and one square meter in section, at 15 deg. C.	0.0175	0.030
Coefficient of the increase of resistance with temperature	0.0039	0.040

Hence the ohmic resistance of a copper wire equals that of an aluminium wire of cross section 1.7 times greater, the substitution of which would result in a saving in weight of 48 per cent. In order that the two wires of equal resistance should cost the same, the price of copper must be only about one half of that of aluminium. The deficiency of aluminium in tensile strength is largely compensated by its lightness, so that spans of the same length can be used for both metals. Aside from the question of first cost the employment of aluminium for aerial lines presents the following advantages and disadvantages:

I. Effect of Wind.—The aluminium wire is more affected by wind because of its greater size, but this is of no importance with wires carried on wooden poles, which always have more than sufficient transverse strength for the usual spans of 130 to 160 feet. On very small (telephone) wires, however, the effect of the wind is too great to permit the employment of aluminium.

II. Effect of Snow and Ice.—Although the aluminium wire is larger than the copper, it does not become more heavily coated with snow and ice, as the quantity of these deposits is found to be independent of the size of the wire.

III. Joints.—The making of joints offers the chief difficulty in the employment of aluminium. Welding with the blowpipe is hardly practicable. The wires must be joined by rivets, splices, cylindrical junction pieces or clamps. A well made splice is generally quite sufficient.

IV. Wiring.—The operation of wiring is much more easily and quickly accomplished with aluminium because of its lightness. Fewer workmen are required and no horse is needed to stretch the wire.

V. Effect of the Atmosphere.—The aluminium should be almost pure, as it is now produced in France and the United States. The failure of the first attempts to use aluminium wire was due to the employment of impure metal. With pure aluminium cases of corrosion are rare, and they are found to be due to smoke or chemical vapors, which would have had the same effect upon other metals. Aluminium is easily attacked by alkalies and chlorine, and should not be used near chemical factories. Sea air does not appear to have any marked action, for the metal soon becomes covered with a coating of alumina, which affords far better protection than the hydrated carbonate formed on copper wires.

VI. Insulated Cables.—Here the conditions are less advantageous, as the greater size of the aluminium cable increases the quantity of insulating material required by 30 per cent. On the other hand the heating is only three-quarters and the weight one-half that of copper, for which at present prices aluminium could be substituted with advantage, especially for high tension cables which require heavy insulation. It has been demonstrated that when the thickness of the wire is increased the thickness of the insulator can be diminished. Apt by experiments with tensions of 20,000, 30,000, and 40,000 volts has proved that the superiority of aluminium increases with the voltage.

Many aerial aluminium wires are already in use in France, the United States and Canada. The French cables carry from 30,000 to 50,000 volts.

TEHUANTEPEC AND PANAMA TRANSISTHMIAN TRAFFIC BY RAIL.

MORE than $60,000,000 worth of American merchandise was carried by rail across the isthmuses of Panama and Tehuantepec in the fiscal year 1909, and in the calendar year which ended with December the total will probably reach $75,000,000 in value. Of the two railways which now carry freight across the narrow neck of land connecting North and South America, that at the Isthmus of Panama is 40 miles in length, the other, at the Isthmus of Tehuantepec, 190 miles. The one at Panama, owned by the government, is, of course, largely devoted to work and traffic growing out of the construction of the Panama Canal; the other at Tehuantepec, 190 miles in length, constructed chiefly with British capital and controlled in part at least by the Mexican government, was built especially for the purpose of handling freight between the Atlantic and Pacific, and, although opened at the beginning of 1907, already has carried about $100,000,000 worth of merchandise passing chiefly between the Atlantic and Pacific ports of the United States. Reports received by the Bureau of Statistics of the Department of Commerce and Labor show that the Tehuantepec Railway, which crosses the Isthmus at Tehuantepec in the southern part of Mexico, carrying the freight received from the steamship lines plying between the great ports of the United States and its eastern and western termini, carried in the first year of its operation—1907—between $25,000,000 and $30,000,000 worth of merchandise; in the second year—1908—nearly $38,000,000 worth, and in the present year will exceed $50,000,000 in the value of freight carried by it. The Panama Railroad, engaged chiefly as above suggested in work in behalf of the Panama Canal, carried in 1907 about $12,000,000 worth of merchandise originating in the United States and bound either for other parts of this country or for foreign countries, in 1908 about $9,500,000 worth, and in 1909 will show about the same total. The merchandise passing over the Isthmian railways in the year ending June 30th, 1909, included $36,000,000 worth originating on the eastern coast of the United States and destined for Pacific ports, including both the United States and foreign countries bordering on the Pacific, and $26,000,000 worth originating on the Pacific coast and at the Hawaiian Islands and destined for the eastern ports of the United States. Of the merchandise crossing by way of the Panama Railroad $9,000,000 worth moved from the Atlantic to the Pacific, and a little less than $2,000,000 worth from the Pacific to the Atlantic. Of the $9,000,000 crossing from the Atlantic side to the Pacific coast by the Panama line, $4,000,000 were destined to the western ports of the United States, and $5,000,000 to foreign countries located upon the Pacific coast of America. The business of the Tehuantepec line, although much larger in its value than that of the Panama route, included chiefly merchandise moving between the eastern and western ports of the United States and the Hawaiian Islands. Of the nearly $52,000,000 worth of merchandise passing over the Tehuantepec line in the fiscal year 1909 over $24,000,000 worth moved from the Pacific end, destined to ports on the eastern coast of the United States, and $27,000,000 worth moved from the eastern end, destined for Pacific ports. Of the $24,500,000 worth of merchandise received at the Pacific terminus of the Tehuantepec road, over $18,000,000 worth was from Hawaii, being almost exclusively sugar for the refineries of Philadelphia and New York, while over $5,000,000 worth originated on the Pacific coast, chiefly at San Francisco, being composed of miscellaneous merchandise. Of the $27,000,000 worth passing westwardly over the Tehuantepec line, $23,000,000 was sent to ports on the Pacific coast—San Francisco, San Diego, and Seattle—and $3,000,000 worth to Hawaii. New York and San Francisco are the chief centers for this ocean and transisthmian traffic between the eastern and western coasts of the United States.—Railway and Engineering Review.

HOW MAN ACQUIRED HIS FIVE FINGERS.

A HAND IS BUT A PROMOTED FIN.

BY CARL W. NEUMANN.

THE history of civilization has been defined as the history of the human brain and hand. The brain is the master, the hand is the servant, and both together have conquered the world. In accepting this concise definition we must take care not to estimate too lightly the share of the hand in the work of conquest. In the whole history of life, probably, the final and decisive victory has always been won by the greater intelligence, and there can be no doubt that the creature endowed with the largest and most efficient brain would have made himself lord and master of all his fellow creatures, even without the aid of the hand. But perfect adaptation to terrestrial conditions, ability to live amid polar ice and under the scroching tropical sun, to rise in the air like a bird and to descend into the depths of the sea like a fish, to overcome obstacles and make them subservient to his purpose—in short, the development characteristic of civilized man could never have been acquired by the most gigantic of brains, without the assistance of the hand.

The history of human culture began with the invention of tools, when the hunter of the mammoth of the ice age first formed a weapon by chipping a flint, and civilization has increased in proportion to the improvement in toolmaking. The hand that made an axe by chipping a flint, and adorned the walls of caves with crude drawings of animals, subsequently created the Venus of Milo and the Sistine Madonna, erected palaces and cities, constructed railways and steamships and airships, always under the direction of its master, the brain.

Hence it is not surprising that the human hand, as well as the human brain, was long regarded as representing the highest stage of organic development. But this view has been found erroneous by palæontology, i. e., the science of extinct animals and plants.

In 1833 large footprints of peculiar form were discovered in the sandstone of Hildburghausen. Ages ago a very heavy animal must have walked over this spot and impressed its feet deeply in the mud, which subsequently hardened into stone. At a still later period a second layer of mud flowed over the first and hardened in turn, so that both the negative and the positive impression, or the mold and the cast, of the animal's feet have been preserved in the two strata. There is nothing wonderful in this process and its results. The remakable circumstance is the striking resemblance of the large hind feet as well as the small fore feet of the animal, to human hands, with a thumb opposable to the other fingers, the various joints of which are clearly discernible in the impressions.

Many similar footprints have since been found and every palæontological museum contains specimens of them, but no bones or other remains of the animal have been discovered. The mysterious creature, which has been named Chirotherium ("hand animal") apparently left nothing except its footprints on the sands of time.

FIG. 1.—FOOTPRINTS OF CHIROTHERIUM.

But although later palæontological researches have contributed nothing to our knowledge of the Chirotherium, they have contributed greatly to the history of the hand. We now know that prehensile hands, with a thumb opposable to the other four fingers, were possessed, not only by the Chirotherium, but also by various lower mammals and amphibia, and by the monstrous dragon-like saurians of remote ages. Hence the hand is not the exclusive possession of man and cannot be regarded as representing the highest stage of development.

The most important acquisition, however, is the knowledge that the extremities of all terrestrial vertebrates are constructed upon a uniform plan, with five parts, one of which is opposable to the other four. Whether the original hand or foot has been developed (or degraded) into the claw or wing of a bird, the wing of a bat, the fin of a walrus, the single hoof of a horse, the double hoof of a goat, the triple hoof of a rhinoceros or the quadruple hoof of a hippopotamus—the farther backward the ancestral history of any of these varied forms is traced, the more closely does the member resemble the human hand, with its five fingers.

The logical conclusion is that all of the higher vertebrates are descended from a common group of ancestors having five-fingered extremities and opposable thumbs. This group must be older than the Chirotherium, whose footprints are found in the Triassic rocks. In the Carboniferous period, hundreds of thousands of years earlier, the dense forests harbored many five-toed amphibia, whose skeletons now adorn our museums. Hence the hand with five fingers must have existed in a still earlier period, the age of fishes, before land animals had been developed.

Can the human hand have originated in the fin of a fish? Science answers "Yes," and points to a very interesting amphibious creature, the Australian mud fish (*Ceratodus*), which has been called a "living fossil" because it is the sole remaining representative of a group of animals that flourished in the beginning of the Carboniferous period. The Ceratodus possesses two systems of respiratory apparatus. In the rainy season, when the bed of its native stream is filled with water, it breathes through gills, like a true fish, but in the dry season it breathes through lungs, like a land animal. These amphibious fishes apparently represent a stage of transition from aquatic to terrestrial forms of animal life, and among them the possessor of the first five-fingered hand must be sought.

The celebrated comparative anatomist Karl Gegenbaur proved that the spines or rays of a fish's fin correspond, morphologically, with fingers or toes. The fins of most existing fishes contain many rays and are very complex and highly developed swimming organs, but the fins of Ceratodus and its extinct near relatives are very much simpler. It resembles a fern leaf or a feather and is composed of a single stout cartilaginous midrib, which bears on each side a number of slender, jointed appendages.

The Ceratodus has four of these primitive fins, which appear predestined to develop into legs, and upon them it often raises its body from the bed of the stream.

If some of the mud fishes of the Devonian period habitually used their fins as legs, and walked on them, the midrib of the fin and such branches as proved especially useful in walking would have been preserved and strengthened in their descendants, while the other branches would have been eliminated by disuse. The result would be a foot with a larger or smaller number of toes. The number five, which forms the original basis of subdivision of the feet and hands of all the terrestrial successors of the mud fishes, must have proved most advantageous, for some reason yet unknown.

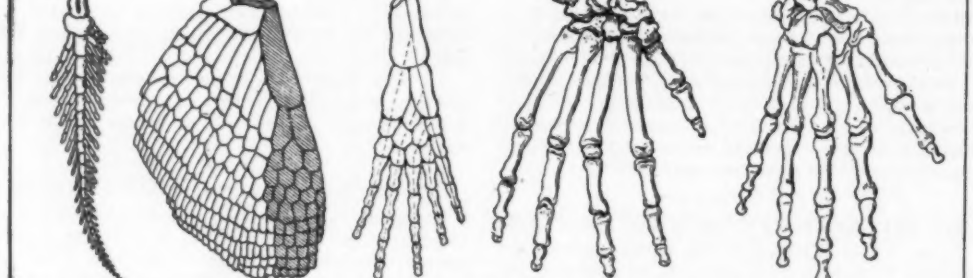


FIG. 2.—EVOLUTION OF THE HUMAN HAND FROM THE FIN OF A MUD FISH.

The evolution of the human hand is illustrated by Fig. 2. The first illustration (on the left) represents the fin of the Ceratodus and the extinct mud fishes. The second illustration represents the pectoral fin of a less ancient fish from which, according to Gegenbaur, the five-fingered member of the amphibia, reptiles and higher vertebrates was developed, by the elimination of the parts which are not shaded in the illustration. Gegenbaur's circuitous method is rejected by later biologists, who assume simply that the midrib of the primitive fin became a thumb and four of the appendages on one side became fingers, as is indicated by the dotted lines in the third illustration, which represents the hand amphibia. The skeleton of a gorilla's hand is shown in the fourth, and that of a human hand in the fifth illustration.

Whatever the exact course of evolution may have been, it appears evident that our five-fingered hands, to which we owe our decimal system of arithmetic, are inherited from Devonian mud fishes that lived millions of years ago.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Reclams Universum.

THE FATE OF THE LONG-HEADED BLOND RACE.

THE Royal Anthropological Institute of Great Britain and Ireland was particularly happy in its choice of Prof. Gustav Retzius of Stockholm as Huxley lecturer for the current year. He is a son of Anders Retzius, who in 1840 divided mankind according to the shape of their heads into *Gentes Dolichocephalæ* and *Gentes Brachycephalæ*, and thereby laid the foundation on which the great superstructure of modern craniology has been reared. In delivering the Huxley lecture at the new premises of the Institute in Great Russell Street, Prof. Retzius dealt with the increase of knowledge regarding the origin and distribution of European races which had attended the application of the methods introduced by his father. A recent survey of recruits for the Swedish army revealed the fact that 87 per cent of the Swedes are "long-headed," while 73 per cent have fair hair. Prof. Retzius regards his fellow countrymen as a pure representation of the North European race—a race still found in Scandinavia, north Germany, and Britain, but at one time spread widely over Europe, from earliest neolithic times downward. They may be regarded as the aborigines of Europe, not, as at one time widely believed, Aryan invaders from Asia. Prof. Retzius agrees with those who take a gloomy view as to the future of this ancient race. The qualities which made them great in the past are just those that unfit them for the routine life of an industrial civilization. The round-headed dark-haired race which has replaced them in central Europe has gained its victory by the possession of superior industrial qualities, a superiority that threatens ultimately to overwhelm the fair-haired northern European stock. Prof. Retzius is not one of those who believe that an industrial mode of life can alter the shape of the head or color of the hair; the evidence in support of such a hypothesis is altogether unconvincing. Such questions, of the very greatest importance to industrial nations, can be settled only by a comprehensive physical survey of the people.—Lancet.

ANOMALIES OF VISION.

SOME CURIOUS ILLUSIONS.

BY A. GRAEF.

THE ease with which erroneous judgments are formed from ocular impressions is strikingly illustrated by a common experience of bicyclists traveling along a straight road through a rolling country. In toiling up a hill the bicyclist is prone to cherish a fallacious hope that beyond the summit he will find a down grade suitable for easy and exhilarating coasting. In going down hill, on the contrary, he feels sure that after reaching the bottom he will be compelled to climb a steeper hill than he actually finds there. In each case he discovers his error before he has reached the top of the hill or the bottom of the valley. The second error is commoner and more marked than the first, and both are increased when the road is bordered by trees which conceal much of it from view. The liability to error is less when the road is curved.

The traveler, in ascending a hill and looking ahead, apparently sees the row of tree tops beyond the highest point sink very rapidly below the level of that point, and concludes that the hill falls very steeply on the farther side. But the distant trees really sink, not below the level of the top of the hill, but below the prolongation of the ascending line drawn from the traveler's eye to the highest visible point of the road. This is illustrated by Fig. 1 *A*, in which *a* is this highest visible point, *o* the eye, and *o a b* the inclined line of vision, below which nothing can be seen. The traveler, however, is apt to assume that his view is limited, not by this inclined line, but by the horizontal line *a d*. Hence, assuming the trees to be of equal height, he pictures them and the road as indicated by the dotted lines in Fig. 1 *A*. In this, as in most cases, the highest visible point, *a*, is not the top of the hill, so that the road immediately beyond *a* actually ascends, but it appears to descend slightly, carrying with it the house which crowns the hill, the lower part of this house being below the line of vision. The error is intensified by the effect of perspective, which shortens the more distant part of the row of trees and therefore makes it appear to descend still more sharply (Fig. 1 *B*) and the concealment of the surface of the ground by the small prominence at *a* removes the usual means of correcting the error due to perspective.

The overestimation of the steepness of a hill which is approached along a down grade is due to similar causes and admits of a similar explanation. The hill, indeed, may exist only in the traveler's imagination. The road may appear to rise beyond the steep descent, though it is actually level or even slightly descending.

When we look at a point which is lower than the eye we estimate its depth below the eye of the angle between the horizontal and the line of sight which leads to the point. The smaller this angle is, i. e., the smaller the effort required to raise the eye from the point to the horizon, the higher is the position which we ascribe to the point. But as the point, without change of level, recedes from the eye, this visual

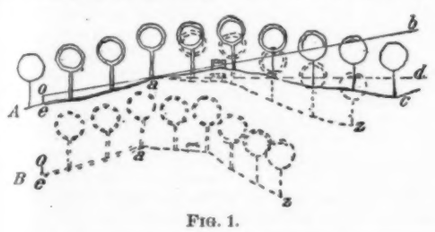


FIG. 1.

angle diminishes. Hence a distant point appears higher than a near point on the same level. Thus to an eye at *o* (Fig. 2) the point *b* appears higher than *a*, *c* higher than *b*, and *d* higher than *c*. In other words, the horizontal line *a b c d* seems to rise as it recedes from the eye. This is a perspective illusion analogous to the apparent mutual approach of two receding parallel lines of posts or trees. For this reason a brook flowing sluggishly along a nearly level bed may appear, to an observer looking downstream, to flow up hill. From a tower erected on a wide plain the distant horizon appears higher than the ground near by, and the plain assumes the appearance of a vast shallow bowl. A German traveler, Von Binder-Kriegistein, has given a graphic description of this effect, as it is produced by the great llanos of Brazil upon an observer standing upon their highest elevations, which do not exceed 160 feet. This hollowing of the landscape is still more apparent to an observer looking from a balloon. Major Gross has observed that the apparent curvature increases with the height of the balloon, and with the thickness of the layer of mist which always covers the earth's surface. Sometimes the effect is so pronounced that a part of the horizon is seen above a low-lying cloud. This appearance, with which most aeronauts are familiar, is due to atmospheric refraction. In general, the pencil of light which extends from an object on the earth's surface to the eye of an observer in a balloon, traverses atmospheric strata of continually decreasing density as it ascends, and consequently assumes a curved form, with its concavity directed toward the

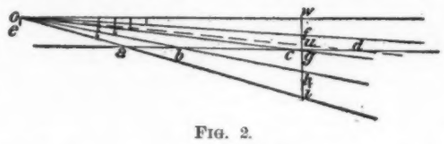


FIG. 2.

earth. Hence the object is apparently elevated, the more so as its horizontal distance from the balloon increases, precisely as the immersed portion of an inclined rod partly covered with water appears to be bent upward. The apparent concavity of the ground is therefore increased by refraction, but this is not its sole cause, for the deceptive appearance is often produced when the elevation of the eye above the ground is too small to include any appreciable difference in the density of the air.

An illusion of similar character affects persons who live chiefly indoors and are not in the habit of looking straight ahead toward a distant horizon. Such persons often bend forward with their heads lowered. This attitude may affect their judgment of the horizontal direction, which they assume to coincide with some such line as *o u* (Fig. 3) instead of *o w*. Their horizon being lowered, the visual angles of low-lying objects are diminished and every such object is elevated, to an extent proportional to its distance from the eye. This is indicated by the dotted lines of Fig. 3 *A*, while Fig. 3 *B* includes also the perspective crowding together of the more distant objects. Some such distorted view is obtained by the city dweller, who with his habitual relaxed bearing gazes down a country road from a hill top, but if he holds his head erect and looks forward horizontally the road appears to sink and stretch. This change in appearance proves that the former apparent elevation of the road was caused, at least in part, by the attitude of the observer. Sailors and persons who live on broad plains are, according to Von Binder-Kriegistein, much less subject to this illusion than the inhabitants of cities and mountain regions. The degree of the error is influenced by various circumstances. The road appears to ascend more steeply when it is shaded by big trees, when the observer occupies an elevated post and when the landscape is uniform and monotonous. Alternations of forest and meadow, crops of different colors, fields and roads give evidence by which the erroneous judgment can be corrected. At a great distance from the eye, however, these details become indistinct and finally unrecognizable. Parts which are equally indistinct appear to be at the same distance from the eye, but the angular elevation increases with the real distance. The result is that the view appears to be bounded by a steep border. If the details of the landscape are obscured by fog or snow this border may rise at a comparatively small distance and a slight incline may present the appearance of a steep hill.

The apparent elevation of the horizon is most striking when a wide expanse of water is viewed from an elevated point. In some cases very peculiar effects are produced. On the southeast coast of Holstein is a peninsula, which is crossed by rows of sand hills, running from west to east. A road crosses these dunes and affords glimpses of the sea from several of the valleys. A stranger can hardly resist the impression that the sea is higher than the valley and on the point of submerging it.

It is extremely difficult to prove whether other persons are or are not subject to the same errors of this sort that an observer may have detected in himself. When questioned, the other person is apt to reply with a curt and careless negative or a polite and equally careless affirmative, according to his disposition. And the subject does not admit of elaborate discussion, as it concerns impressions which are purely personal and also erroneous. There is even danger that an introspective person whose attention has been called to the subject may create in himself erroneous impressions which did not previously exist. Of especial value, therefore, is the voluntary, uninfluenced testimony of Von Binder-Kriegistein and of persons who seemed to see water run uphill. The most valuable observations are those which are made unconsciously, in cases when the erroneous impression is so strong that the discovery of the truth produces a feeling of surprise.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

A CASE OF RAPID VARIATION OF AN INSECT SPECIES.

AN experiment performed by Marchal last year has reopened the question of the formation of a new species. The experiment was made with *Lecanium robiniarum*, a coccid which infests the acacia. The coccids form a family of hemipterous insects which includes the cochineal and kermes insects. The *Lecanium* resembles the cochineal insect, from which it differs chiefly in the curious life history of the female, which dies and becomes transformed into a sort of shield fastened tightly over the eggs and the leaf which carries them, so as to protect them very effectively. *L. robiniarum* has been known only about thirty years, and it was described as a distinct species in 1890 by Douglas, the leading authority on this subject. It is improbable that this species previously existed on the acacia, for as the insect is as large as a pea, it could not escape observation, both in Europe and in America, the home of the acacia. Hence it has been suggested that this species has been developed recently from another species of *Lecanium*. Marchal conjectured that this parent species was the very similar *L. corni*, which is a parasite of the peach, the rose and the grape vine.

According to Cosmos, Marchal placed on an acacia tree (taking proper precautions for isolation) a laying female of *L. corni*. The eggs were laid and the larvæ developed upon the acacia. When the insects had attained the adult stage, four of them were found identical with *L. robiniarum*. Here, then, this type were certainly produced by *L. corni*. Marchal did not succeed in accomplishing the reverse transformation by placing *L. robiniarum* on peach trees, rose bushes or grape vines. He concludes from his observations that *L. robiniarum* is only a variety of *L. corni*. Such, indeed, is the common method of regarding such phenomena in systematic zoology; but the advocates of the theory of mutation prefer a different interpretation. Caullery and Mesnil see in this result an example of the formation of a new species by adaptation to new conditions. In the absence of experiments of this kind, the systematists had regarded *L. robiniarum* as an independent species, and it may be supposed that more than one species, distinguished by them, would give similar results if similar experiments were performed. The formation of a new type is furthermore

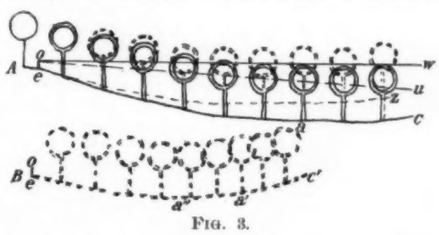


FIG. 3.

a confirmation of the views of Lamarck. This experimental case, though very interesting, cannot settle the fundamental controversy between the advocates of fixed species and the transformists, but it may lead to a more precise definition of the characteristic elements of a botanical or zoological species.

A type of Leclanché battery has been patented in France in which the present electrolyte of sal ammoniac is replaced by chloride of manganese. It is claimed that the cell holds up much better in this case, and that it can be short-circuited without harm. It has no consumption on open circuit. The internal resistance of the battery is low, and it has a large effective yield. Besides, the liquid does not freeze in extreme cold. A novel feature lies in the fact that the exhausted battery can be regenerated by charging it by an outside current.

VENUS AND ITS PROBLEMS.*

ITS ROTATION AND ITS POSSIBLE LIFE.

BY T. J. J. SEE.

THE question of the rotation of Venus presents great interest owing to two leading considerations:

(1) A rapid rotation of the planet on the axis which would give alternation of day and night, if not absolutely necessary for the development of life, would at least be highly favorable to the existence of animals and plants as known on the earth; and if such rotation could be assured for Venus, the outcome would go a long way toward establishing the habitability of the earth's twin sister in space.

(2) The question of the secular effects exerted by tidal friction in retarding the earth's rotation needs illumination from other sources; and of all the possible bodies to which we can appeal, this inner planet, Venus, presents the most favorable conditions for a satisfactory answer. It is the only planet whose rotation period would be likely to prove absolutely decisive for or against tidal friction as an effective cause in modifying the rotations of the bodies such as we find in the solar system.

With these two weighty problems hanging in the balances, it is clear that Venus presents to us at present a far greater interest than any other planet. The study of it is ten times more important than Mars, on which we bestow so much attention; and not even the rare visit of Halley's comet is likely to give us permanent data to be compared with a really reliable determination of the rotation period of Venus.

It is the more remarkable that so little attention has been given to Venus, because it is easily within reach of a very moderate-sized telescope. Probably most observers have considered the study of the planet a hopeless one, but this certainly is not the case. Nothing but diligence and good atmospheric conditions are required to give data of the greatest value, and they are likely to be gathered by some one who seizes the opportunity at the present inferior conjunction of Venus.

We give below a discussion of the periods found by several observers since the time of Cassini in 1667, but will first point out the objections to a period of about one day as stated by several writers. These objections rest on the close agreement of the Cytherean day with our terrestrial day, and the possibility of periodic deception; but those advancing such views evidently have never examined the original records of Schroeter (1789-1795) and are unaware of the fact that the phenomena of the indentation of the southern horn, to which he gave so much attention, scarcely admits of an interpretation based on mere optical illusion. The indentation of the southern horn is very plain under good conditions, and no division of opinion is possible among experienced observers; for I have myself observed this indentation very plainly with the 26-inch refractor at Washington, and made a drawing of it almost identical with those given by Schroeter in the Philosophical Transactions of the Royal Society for 1792.

In one of his records Schroeter states (Philosophical Transactions, 1795, pp. 117-176) that he saw the indentation plainly disappear after about eleven minutes, and from records made on two successive days found that the Cytherean day is about forty minutes shorter than the terrestrial.

In making the second observation on the indentation of the horn, February 27th, 1793, he was unaware of the time recorded on the previous day, and thus all bias or prepossession of mind was avoided.

It must be admitted that a day of 23 hours 21 minutes for Venus cannot easily be explained by a deception. For why should the different observers all reach about the same result, giving a day 35 minutes shorter than our terrestrial day, instead of a day of almost exactly 24 hours? Evidently no good reason can be assigned for assuming that experienced planetary observers such as Schroeter were deceived.

If on the other hand we turn to the modern spectroscopic observations, we find them in conflict among themselves. Belopolski found indications of a period slightly shorter than a day (A. N. 3641), while Lowell and Slipher, repeating the observations, got no indications of a rapid rotation (A. N. 3891). Schiaparelli's visual observations (A. N. 3304) are not as conclusive as one might wish, and Lowell came to reject his early maps of Venus as illusory. (A. N. 3823). The only clear evidence that we have therefore is the early observations of Schroeter, which are remarkably convincing; and the later observations of DeVico, which confirm Schroeter's work in every respect. Schroeter found the time of rotation to be 23 hours 21 minutes 21 seconds, and DeVico changed this period by less than a second, his final result being 23 hours 21 minutes 21.934 seconds.

Finally, it may be added that I have detected a theoretical cause which would tend to make the rotation of Venus more rapid than that of the earth, while that of Mars would be slower; but it is not advisable to go into that at present, and we content ourselves with discussing the old observations and pointing out a piece of work within the reach of an industrious amateur.

* Popular Astronomy.

DEEP-SEA LIFE.

STRANGE INSTANCES OF ADAPTATION TO ENVIRONMENT.

BY GLADYS GRAHAM MURRAY.

NATURALISTS of olden days were of the opinion that there was an absence of life in the deep seas. To-day this theory is known to be incorrect, and the fact that a deep-sea fauna exists is familiar to every zoologist.

The relationship between animals and their environment is a subject which deserves close attention, for, little by little, animals modify themselves to the conditions under which they live. It is therefore interesting to consider the physical conditions of the mighty deep. To these enormous depts no sunlight can penetrate, for it has been reckoned that after a depth of five hundred fathoms (three thousand feet) the sun's rays will be unable to pierce their way. Such illumination as exists in very deep waters is doubtless due to the fact that many deep-sea fish possess phosphorescent organs.

The late Sir Wyville Thomson wrote that after he left Cape Verde Islands the sea was a blaze of phosphorescence: "There was no moon, and although the night was perfectly clear . . . the luster of the heavens was fairly eclipsed by that of the sea. It was easy to read the smallest print sitting at the afterport in my cabin, and the bows shed on either side rapidly widening wedges of radiance so vivid as to throw the sails and rigging into distinct lights and shadows."

If phosphorescence such as this exists at great depths it accounts for the well-developed eyes and brilliant colors of some of the deep-sea animals; on the other hand, a large proportion of the denizens of the deep possess either no eyes or eyes reduced to mere vestiges.

At great depths there is no movement of the water, no tides are felt, and no gales blow to ruffle the bottom of the abyss. Owing to the absence of sunlight plant life ceases to exist, and a vast silence must reign perpetually. It is difficult to realize the immense pressure of such deeps, for at a depth of over two thousand five hundred fathoms (fifteen thousand three hundred feet) the pressure per square inch is two and a half tons; whereas on land the pressure exerted is under fifteen pounds per square inch. Should the fish therefore inhabiting these depths get carried upward to the surface, the swimming bladder becomes greatly expanded, and when they reach daylight generally bursts.

It is interesting to consider the question of the temperature of the sea. Deep water is always very cold, but owing to the influeuce of polar currents the temperature for a given depth may not be the same. Research has shown that in the Atlantic Ocean there is a strong predominance of the Antarctic polar current.

The carpet of the deep sea is composed of different muds and oozes. Globigerina ooze is that which is chiefly composed of the shells of that minute animal life, the *foraminifer*. It is found at depths ranging from five hundred to nearly three thousand fathoms in equatorial and temperate latitudes, but not in Arctic seas. Ninety-five per cent of this ooze is made up of carbonate of lime.

The commonest of sea deposits is that known as red mud. This is said to exist over one-third of the earth's surface. The shells of the different animals are acted upon by the free carbonic acid which sea water contains, and they are quickly ground down by this powerful solvent. Another ooze is radiolarian ooze, in which almost no trace of carbonate of lime is found; this occurs in the deepest waters of the central and western Pacific Ocean, while in the deep water near the Antarctic circle a diatom ooze is found.

Zoologists of to-day make a special study of the geographical distribution of terrestrial animals, mapping out the world into different regions and sub-regions; but there is always some debatable ground, for Nature has no set limits, and one fauna will gradually merge into another. In the sea no mountain ranges or great deserts act as barriers; consequently the fauna of the ocean varies according to the temperature, pressure, the amount of light, the salinity of the water, and the food supply.

Three great primary zones are recognized. These are the Pelagic, the Neritic, and the Abysmal zones. The Pelagic zone includes the superficial waters of all seas; while the Neritic (or shallow-water zone) embraces all depths less than five hundred fathoms, including inland seas, shores of great continents and isles, and shallow banks in the great oceans. The last well-marked zone is the Abysmal, which extends from the 500-fathom line to the greatest depths of the ocean.

It is interesting to consider the views which are advanced by naturalists as to the origin of the mighty abysmal fauna; and the question arises as to whether the curious creatures that live at such mighty depths—many of them in total darkness—are the remnants of the fauna of shallow prehistoric seas, or are the progenitors of the shallow-water population. The explanation which is generally accepted, and which was put forward by the late Prof. Mosely, is that the fauna of the deep sea has been derived from successive immigrations of the animals inhabiting the shallow water; and this theory is greatly strengthened by the fact that, as a rule, the deep-sea fauna is much richer in the neighborhood of land than in regions far from it.

Marine animals pursue three great modes of life. There are those—such as the jelly fish or medusæ—which float and drift with the currents of the sea, and are scarcely able to determine for themselves the direction in which they travel. This portion of the ocean's fauna is called the *plankton*, while the *nekton* are those animals which are capable of vigorous swimming movements, and are able to migrate freely from one part of the sea to another. Lastly, there are those animals which remain as fixtures, or are only capable of crawling over the rocks or sand; and to this group the name of the *benthos* has been given.

It is interesting to look at the colors of the skin of the different deep-sea animals, which vary to a remarkable extent in the separate groups—some brilliant colors being found in certain cases, and in others a somber hue predominating. Among the mollusca violet is the prevailing color, and in a specimen brought home by the "Challenger" expedition a rose-colored denizen of the deep was reported. Various shades of red seem to prevail among the crustacea, while the large eggs of some of the deep-sea genera were of a brilliant light blue. This latter color is very rarely met with in the fauna of the abyss. To turn to the deep-sea jelly fishes, deep violet or a yellowish-red hue is said to predominate; while Agassiz reported a particular species as being remarkable for the light carmine tint. In speaking of corals and deep-sea anemones, the same

author recorded that "some deep corals were scarlet, deep flesh-colored, and pinkish orange."

The eyes of the deep-sea inhabitants have undergone some curious modifications. In the majority of cases it is usually found that the eyes are either very large or very small. A species of fish dredged up from a depth of over one thousand two hundred feet by the "Porcupine" expedition possessed a pair of well-developed eyes on short footstalks. In some cases the loss of sight is greatly compensated by the high development of the tactile organs, which probably possess a very delicate sense of touch.

Many deep-sea animals have the power of emitting phosphorescent light, some possessing distinct organs for this purpose. Certain sharks secrete a highly phosphorescent slime in their ski nglands; whilst other deep-sea fish display curious eye-like organs down the sides of the body, forming, as it were, a series of miniature bull's-eye lanterns. Again, others possess glandular organs behind the eyes or on the head and shoulders.—Chambers's Journal.

SCIENTIFIC FACTS ABOUT EGGS.

THEIR CHARACTER, SELECTION, HANDLING.

THE rules for telling eggs with the candle from now on are as follows:

Forty-eight hours: By this time the opaque white membrane which surrounds the germ has spread well over the top of the yolk, and the egg is quite dark or heavy before the light. Blood appears at about this period, but is difficult of detection with the candle, unless the germ dies and the blood ring sticks to the membrane of the egg.

Three days: The candle shows changes in this egg that are apparent even to a novice. An experienced candler will have no difficulty in seeing the blood ring through the shell. When broken the blood ring is the prominent feature, and is as large as a nickel. The yolk behind the membrane has become watery.

Four days: The body of the chick becomes visible to the candler, and the prominent radiating blood vessels are seen. Upon breaking, the yolk is found to be half covered with the sac containing water.

The developments given above occur at a temperature of 103 deg. F. As the temperature is lowered the rate of chick development is retarded, but at any temperature above 70 deg. chick development will proceed far enough to cause serious injury to the quality of the eggs.

For commercial uses the customary grouping of eggs in regard to heating is:

1. No heat shown. Cannot be told at the candle from fresh eggs.
2. Light floats. First grade that can be separated by handling corresponding to about eighteen to twenty-four hours' incubation.
3. Heavy floats. This group has no distinction from the preceding, except an exaggeration of the same features. These eggs are objectionable to the fastidious housewife because of the white and scummy appearance of the yolk.
4. Blood rings. Eggs in which blood has developed, extending to the period when the chick becomes visible.
5. Chicks visible to the candle.

The loss to the egg trade due to heated eggs is probably greater than that from any other source.

The Texas egg business is virtually dead from June 15th to the fall. The heat ruins the product and kills the profit. That is generally true over the South. The Southerner eats few eggs in the summer.

The egg shell is porous. This is contrary to common experience. The developing chick needs air. Warm temperature and dry air striking eggs cause evaporation and produce the grade called shrunken eggs. Rough handling of shrunken eggs causes a rupture of the inner membrane. This allows the outer air coming through the porous shell to get into the contents of the egg. Thus is produced the "watery" or "frothy" egg. This does not hurt the edible value of the egg, but it gives it a bad trade name.

"White strength" is simply the stiffness of the egg white. Age and mechanical disturbances weaken the network of fibrous material as in shrunken eggs. These eggs will not stand up well or whip into a firm froth. The yolk weakens and breaks also. The food value of the egg is not affected thereby. It simply looks bad, spoils for poaching and whipping.

Farmers and grocers hold eggs so long in the summer for better prices that "fresh eggs direct from the farm" from August to December are the exception. They come direct, but are far from fresh. They are not held in cold storage. Most of these are classed as shrunken eggs. They are so well understood as to be left to become a drug on the market.

The egg, when laid, is virtually germ free; seldom has it any bacteria. The egg shell is sufficiently porous to admit germs, after the egg has been dropped. The fiber-crisscrossed membrane within is germ proof when kept dry. Eggs may be affected by moisture in many ways, when the egg-rotting bacteria may be deposited and interred. The following are the chief classes of egg-rotting bacteria.

1. Black Rots.—It is probable that many different species of bacteria cause this form of rotten eggs. The prominent feature is the formation of hydrogen-sulphid gas, which blackens the contents of the egg, giving the characteristic rotten egg smell and sometimes causing the equally well-known explosion.

2. Sour Eggs or White Rots.—These eggs have a characteristic sour smell. The contents become watery, the yolk and the white mixed, and the whole egg offensive to both eye and nose.

3. The Spot Rot.—In this case the bacterial growth has not contaminated the entire egg, but has remained near the point of entrance. Such eggs are readily picked out with the candle, and when broken show lumpy adhesions on the inside of the shell. These lumps are of various colors and appearances. It is probable that spot rots are caused as much by mold as by bacteria, but for practical purposes the distinction is immaterial. The responsibility for decayed eggs is chiefly with the farmer.

There are moldy eggs, caused by wetting the cases, damp cellars or the sweat of iceboxes. These usually are afflicted with the spot rot. The musty egg is free from organisms.

Eggs should never be stored in musty cellars, or in rooms with citrus fruits, vegetables, fish or cheese. The egg takes on the odors of those products and prejudices the fancy trade.

The following is a summary of the approximate losses to the egg trade, due to detrimental changes: "Dirties," 2 per cent; breakage, 2 per cent; chick development, 5 per cent; shrunken or held eggs, 5 per cent; rotten eggs 2½ per cent; moldy eggs, ½ per cent. In all, 17 per cent.

Eggs are naturally worth more, intrinsically, when laid than when they reach the consumer. If marketed as laid, the eater of low-grade eggs would eat real fresh eggs, but pay a higher price for them. This would probably force him to substitute other food for his egg diet.

The American egg crop is gathered and marketed about as follows:

The eggs are gathered by the farmer with varying regularity and are taken, perhaps on the average of once a week, to the local village merchant. This merchant receives weekly quotations from a number of surrounding egg buyers, and at intervals of from two days to two weeks ships his eggs by local freight to such dealers. The dealer buys the eggs "case count"; that is, he pays for them by the case, regardless of the quality. He usually repacks the eggs in new cases and may or may not candle them.

This dealer in turn receives quotations from city egg houses and sells the eggs by wire. He usually ships in carload lots. The city receiver may also be a jobber who sells to grocers, or he may sell the carload outright to a jobbing house. The jobber recandles the eggs, sorting them into a number of grades, which are sold to various classes of trade.

The loss in candling is generally kept account of, but is seldom charged back to the shipper.

By "loss off" or "rots out" is meant the subtraction of the bad eggs from the number to be paid.

The jobber grades the eggs as the trade demands. In New York there are as many as seven or eight grades. The finest are packed in sealed cartons. The first-class hotels, clubs, restaurants and soda fountains buy the strictly high-grade eggs. The elements of cost for a dozen eggs purchased in New York for 25 cents run about as follows: Paid the farmer, 15 cents; profit to shipper, ¾ cent; freight to New York, 1½ cent; gross profit of receiver, ½ cent; gross profit of jobber, 1¼ cent; loss from candling, 2 cents; gross profit of retailer, 4 cents. Total, 23 cents. Any increase along the cost line increases price to consumer.

Bakeries and low-class restaurants take the cheapest grade of eggs.

Boards of health have difficulty in preventing the sale and use of "spot rots" and low-grade eggs. The dead line between dead chick and other low-grade bacteria contaminated eggs cannot be well defined. The buyer must use his judgment.

The fact remains that farmers' eggs, whether shipped direct to the consumer or to the merchant, may not be fresh in any sense. They may have lain in the sun or other heat days after having been laid, or may have been kept under unfavorable conditions until enough were gathered for the market. The indifferent results obtained in making dressings and other dishes where eggs form an important item is often due to the use of eggs laboring under some affliction that does not disqualify them in any sense as a wholesome food. The pastry or other cook will avoid much trouble on this score by a careful study and examination of the character of his egg component before using it. The jobber simply grades the eggs as the trade demands. A reliable jobber who knows the uses to which his customer wishes to put the eggs bought is a valuable man to aid the steward or other buyer in the selection of the stock for his purposes. If the customer is not an expert at all the stages the capable merchant should be cultivated, as he grades to suit the case and becomes a great and needed help in the proper selection of eggs for needs of the consumer.—Spatula.

RECENT PROGRESS IN ELECTRICAL ENGINEERING.

DR. KAPP, the president of the Institution of Electrical Engineers, in his inaugural address, passed in review the industrial progress that had been made in electrical engineering during the last ten years, and pointed out the changes that had been made in the design of electrical apparatus. The modern practice is to use very large generators and to drive them by turbines. The manufacturers are prepared to build machines, which have an output of more than 20,000 horse-power, and generate electricity at 15,000 volts. These large machines are particularly useful in the electro-chemical industries, especially those for "fixing" atmospheric hydrogen with the object of producing a fertilizer to replace Chili saltpeter. Electric arc furnaces are used by the Norwegian Nitrogen Company, and their yearly output is 20,000 tons of nitrate of lime. By 1911 it is expected that the production will have increased to 100,000 tons. The process is entirely electrical. No fuel of any kind is used. The heat required for steam raising and other purposes is obtained as a waste product from the electrical furnaces. Dr. Kapp gave some interesting particulars of the applications of electricity to stimulate the growth of plants. Until Sir Oliver Lodge took up the problem of utilizing Lemström's discovery that the electrification of the atmosphere immediately above growing crops had very appreciable effects both on the height to which they grew and the weight of the ears produced, very little progress had been made. In Lodge's arrangement a network of galvanized iron wires is stretched over the field to be treated, and is suspended at a height of 18 feet from the ground by means of wooden poles with oil insulators. About one post per acre is required. The network is positively electrified to between 60,000 and 100,000 volts by means of an induction coil and a dynamo driven by a small hot-air engine. The power required is very small, but under the treatment the increase in the yield per acre is about 30 per cent. The system is in use on several farms in this country, and on six in Germany, so convincing data should soon be available. In conclusion, Dr. Kapp pointed out how the introduction of electricity into our great industries could be accelerated by reading papers at the local sections, which would be of interest to the particular industries in the neighborhood.

Waterproof Paint for Brick Walls.—This consists of two consecutive coatings, of which one is composed of soap and water (1,000 parts water to 300 parts soap) and the other of alum and water (200 parts alum to 4,000 parts water). The wall must be perfectly dry and clean, the temperature of the atmosphere not higher than 50 deg. F. The soap coat is first applied with a brush in a boiling hot condition. It dries in 24 hours and hardens; then comes the alum coating, at a temperature of 60 to 70 deg. F. After 24 hours the entire process is repeated, and this is done until the wall becomes impermeable to water. The number of applications necessary is governed by the pressure of water to which the wall is exposed.

ENGINEERING NOTES.

An air steam engine has been invented by a professor of engineering in one of the Western colleges of this country. In this invention a cylinder is filled with compressed atmospheric air into which saturated steam is introduced. The chief merit claimed for this system is that cylinder condensation is almost totally avoided by the high temperature of air compression and the high superheat of the mixture.

The Ganz steam motor car built by the Railway Auto Car Company and tested by the Chicago, Rock Island and Pacific Railroad about a year ago, has been returned to the railroad fitted with a new Ganz engine of low steam pressure and a new Baldwin boiler and superheater. The car will shortly be placed in service on one of the company's branch lines.

It is sometimes difficult when necessary to use a car jack on unpaved sections of the line to find a firm foundation upon which to work. To avoid trouble from this condition, the motormen of the Grosse Berliner Street Railways have been advised to take a motor trap-door from the car for a jack base. The men are also provided with small wooden blocks to keep the door in a horizontal plane where the roadway is very uneven.

Heavy explosions in the sewers of a portion of New York city containing many garages, states a contemporary, again draw attention to the danger of allowing petrol to enter sewers. Some of these explosions were so violent as to resemble the explosion of a small boiler. Manhole covers were blown into the air, windows in the neighborhood were shattered, and a number of persons injured. The sewers of the city discharge into tide water, and at high tide the sewage in them backs up in some cases. It is probable that petrol floated on the surface of the sewage when the latter was backed up by high tide, and its vapor was ignited by a spark that might have been due to several causes. While such explosions will not follow every discharge of petrol into sewers, their occasional occurrence and the possibility of much serious injury from them, states our contemporary, are a justification for rigid rules efficiently enforced to prevent the practice.

The bond between concrete and steel, as influenced by repeated loading, has been investigated by Prof. B. Kirsch, of Vienna, and a summary of the work was presented to the Copenhagen Congress of the International Association for Testing Materials. The bars were plain 20 mm. square, some rusty and some bright, and were tested by embedding one end in a 1 : 3 Portland cement mortar cube of 20 cm. edge. The adhesion surface was 125 square centimeters, and the load applied was 150 kilos., amounting to 1.2 kilos. per square centimeter, or 17 pounds per square inch of bonding surface. The load was applied fifty times, this limit being set because Prof. Kirsch believes that any loosening of the bar, if noticeable, would become apparent after a few applications. The experiments on specimens one month and three months old convinced Prof. Kirsch that a repeated load of 17 pounds per square inch does not produce any alteration in the adhesion, either with bright or rusty bars. The cubes, on the completion of the adhesion experiments, were tested in compression, the rods being left in them, and developed strengths of 1,520 pounds and 1,790 pounds per square inch for the one-month and three-month cubes respectively.

A coal dust experiment gallery near Sebengottes, Austria, is described in the Iron and Coal Trades Review. Experiments are still in progress at this gallery under the auspices of the Vienna committee on fire damp with the object of determining conditions under which coal dust is likely to explode. The gallery, which is 964 feet long, is constructed of masonry and is buried under from 6½ to 70 feet of earth, the depth of earth covering decreasing as the distance from the explosion chamber increases. The explosion chamber is of concrete, 6 feet high, 6½ feet long, and 4¼ feet wide. The arched roof of the gallery is 6¾ feet above the floor at the end nearest the chamber and its height increases to 7¾ feet at the farther end. The gallery is equipped with sloping wooden ledges for coal dust and with apparatus used in investigations of the efficacy of preventive measures such as wet zones, water sprays, and zones of stone dust. The length of flame produced by the explosion is measured by means of sulphur matches placed along inside the gallery at intervals of 40 inches. Samples of the fumes produced by the explosion are obtained by means of loosely corked bottles of water suspended bottom up in the gallery 33 feet from the explosion chamber. Strings attached to the corks are fastened to the nearest rack of shelves which are hung at intervals in the gallery to hold coal dust. The movement of the shelf racks due to the explosion draws the corks and the water runs from the bottles and is replaced by gas. The samples thus obtained are found to contain 0.8 per cent to 6.45 per cent carbon dioxide, 0.3 per cent to 3.2 per cent carbon monoxide, and 10.95 per cent to 18.3 per cent oxygen.—Engineering News.

ELECTRICAL NOTES.

Steam and electric traction on the same tracks has been in operation on the Colorado and Southern Railway for about 26 miles out of Denver, Colo., since May, 1908. No difficulty has been experienced in the operation of trains, and it has not been found that smoke or steam has in any way damaged the overhead construction. The electric cars operate a suburban and interurban service auxiliary to the steam train service.

The Marmier and Abraham process of sterilizing water by ozone from electric apparatus was one of the best in the recent concourse held by the city of Paris, and the cost of sterilizing a cubic meter of water was the lowest. The test was made upon a current of 300 cubic meters of water per hour, and the electric current cost 0.055 franc per kilowatt-hour, with labor 1.40 francs per hour (two attendants). The figures for the total expenses, including interest and depreciation, show that a cubic meter can be sterilized by the process for 0.0098 franc, or about 0.2 cent.

It is proposed to erect an electric generating plant on the Colorado River at what is known as the Needles, situated about 25 miles south of Powell, Ariz. Col. C. E. Apponi has secured the water rights to a strip of the river territory five miles in length at the first rapids, and it is at that place the plant will be situated. A complete survey of the site has been made, and a syndicate of Milwaukee has been interested. The initial plant will have a capacity of 30,000 horse-power, and a number of transmission lines to supply towns and industrial plants within a radius of 170 miles of the generating plant will be erected. There are also many mines within the proposed radius. A large dam will be constructed, a storage reservoir will be built, and a system of canals will be utilized for irrigation purposes over a large area of land. The estimated expenditure is about $200,000.

Among the electrical exhibits at the Brescia Exhibition, states the Electrician, is a complete installation of the Bellini-Tosi system of directive wireless telegraphy. Owing to the confined space—for the exhibition is held in part of the Castle of Brescia—the transmitting and receiving stations are only 40 m. apart; but, with the exception that the antennæ employed are reduced to only 3 m. in height, all the other apparatus is of full size—in fact, the radio-goniometer at the receiving station is the actual apparatus which is to be erected in the new station of the French government (post office) which will shortly be opened at Boulogne. All the special features of the system, such as directive emission and reception of the waves and location of the direction of the transmitter, can be readily demonstrated, in spite of the small distance between the stations.

The Electrical Review and Western Electrician gives an account of an electrically-driven rail bender in which the framework of the machine is a heavy steel casting made in one piece, the solidity of which insures regularity of curvature and rapidity of work, which, with the small amount of manual labor required, renders the tool extremely useful on construction work. The power-driven bending roll is mounted in a frame which is driven forward to give the desired curvature by a hydraulic cylinder, the power for which is a small hand pump mounted on the frame of the tool above the cylinder. The roll can be driven out under a pressure of 50 tons. The two fixed roll centers are 34 inches apart. The driving roll is geared to make one turn to eight turns of the pulleys, which are 24 inches in diameter and have a 7-inch face. The bending rolls are changed by loosening set screws and pulling out the pins. The arm holding the middle bending roll can be worked in and out by a lever without the aid of the pump, if the release valve is open, so that the pump is necessary only when bending a rail to get the desired curvature. The capacity of the machine is about one medium length rail per minute when once adjusted.

According to a contemporary, Prof. Fessenden has proposed to the United States Navy Department the building of a turbo-electric vessel, wherein a steam turbine alternator would drive the propellers through induction motors, but so far the proposition has not been accepted. The claim is that there would be a great saving in weight, as the turbine could be operated at an efficiently high speed and so be made much smaller than when designed to be directly connected to the propellers. The same object, states our contemporary, will probably be more economically accomplished by the marine turbine reducing gear patented jointly by Rear Admiral George W. Melville, U. S. N., retired, formerly chief engineer of the United States navy, and Mr. John H. McAlpine, who was also formerly in the navy. The first model of this gear was recently completed at East Pittsburg, Pa. It consists of a floating frame supporting two spiral gears. Each has a 22-inch face; the smaller, of 14 inches pitch diameter, is connected to the turbine shaft, while the larger, of 70 inches pitch diameter, is connected to the propeller shaft. The tensile strength of the steel used is 90,000 pounds per square inch, and it is expected that the gear will transmit 6,000 horse-power. It is suggested that it will greatly reduce the weight and cost of transatlantic steamship and battleship power plants.

TRADE NOTES AND FORMULÆ.

Paint for Iron Ships.—600 parts of asphalt or black pitch, mixed warm with 480 parts of boiled linseed oil; to this add a mixture of 600 parts of graphite, 120 parts of arsenate of copper, 640 parts of refined oil of coal tar. To be applied hot.

Waterproof Paint for Stone.—Equal parts of palmitate of alumina and rosin are melted together, or palmitate of alumina and wax mixed, and this mixture dissolved in caustic soda lye and water. After application and drying, rinse off with a weak solution of sulphate of alumina in water.

Paint for the Mortar of Brick Walls.—84 parts of fine drifting sand, 12 parts of unslaked lime and 4 parts of skim-milk cheese that has been pressed through a wire sieve. These substances are to be first well mixed dry, then with a sufficient quantity of hot, not boiling, water, prepared for application. It must be quickly applied.

Paint for Metals.—10 parts of finest powdered stick sulphur is dissolved, with the application of heat, in 90 parts of oil of turpentine and mixed with 50 parts of linseed oil varnish. This very firmly adhering paint can be colored black by the addition of lampblack, brownish red by the addition of English red, and white by means of zinc white.

Waterproof Paint, according to Hafen.—Boil 7,500 parts of linseed oil with 331 parts of rosin, 330 parts of litharge, 50 parts red lead, and 50 parts umber; gradually add 230 parts of zinc vitriol and a solution of 350 parts caustic potash, 350 parts of alum, 15,000 parts of chalk, 1,000 parts of zinc white, with 3,000 parts of water, in which 40 parts of alum have been boiled; then add a decoction of 750 parts of glue with 2,000 parts of water. The paint is mixed with 2,000 to 2,500 parts of varnish, and the mixture thinned with petroleum.

Protective Against Moths.—Carbolic acid is recommended for use in fighting moths. For cloth storage use the following mixture: 45 parts pure carbolic acid, 30 parts camphor, 30 parts oil of rosemary, 5 parts oil of cloves, and 5 parts of aniline dissolved in 2,500 parts of alcohol. For furriers: 20 parts pure carbolic acid, 10 parts oil of cloves, 10 parts oil of lemon peel, 10 parts nitro-benzole, 2½ parts aniline dissolved in 1,500 parts of pure alcohol. With this fluid the goods are moderately sprayed with the help of an atomizer. If they are kept in tight packages, one spraying will suffice for the season. Cloths in storerooms will require twice spraying. Another very effective method of making cloth and other fabrics waterproof, and, at the same time, preventing their destruction by moths, is: 10 parts of alum and 10 parts of sugar of lead, dissolved in the necessary quantity of water, are mixed together and the mixture allowed to remain undisturbed until the precipitate of sulphate of lead has settled. The clear fluid, which will now contain acetate of alumina, is poured off and mixed with a large quantity of water, in which dissolved isinglass has been stirred. The objects to be protected are immersed in this mixture and left in it for 12 hours, until they are saturated, after which they are allowed to dry and finished by pressing or some other method. Fabrics made waterproof in this manner are not attacked by insects. Another means of protection from ravages by moths (for upholstered goods) is the following: Horse hair, such as is used for upholstering, must be colored yellow by picric acid (30 parts picric acid to 10,000 to 12,000 parts of water). As the picric acid is not volatile and is not scattered, if furniture, upholstered with hair colored yellow by picric acid, is beaten, no injury to human beings is to be apprehended, while the protection against moths is absolute.

TABLE OF CONTENTS.

PAGE

I. ANTHROPOLOGY.—How Man Acquired His Five Fingers.—By KARL W. NEUMANN. ... 44

II. ASTRONOMY.—The Rotation of Venus and Life on Planets Other than the Earth.—By T. J. J. SEE. ... 45

III. AUTOMOBILES.—A New Automobile Boat. ... 40

IV. BIOLOGY.—Deep Sea Life.—By GLADYS GRAHAM MURRAY. ... 46

V. ELECTRICITY.—A German Electric Dredger and Locomotive Haulage Equipment.—2 illustrations. ... 33
Wireless Signaling in Aeronautics.—By F. H. MCLEAN. ... 34
Electric Wires of Aluminium. ... 45
Electrical Notes. ... 48

VI. ENGINEERING.—Tehuantepec and Panama Rail Traffic. ... 43
Reclaiming Mesopotamia. ... 39
Engineering Notes. ... 46

VII. MISCELLANEOUS.—The Custom of War. ... 38
The Different Phases of Matter. ... 43
Color Action of Metals in Alloys. ... 43
Eggs—Their Character, Selection, Handling. ... 47

VIII. NAVAL ARCHITECTURE.—Keel Water and Its Causes.—By Naval Constructor ULVERS. ... 37
The Non-magnetic Ship "Carnegie."—By E. A. DIXIE.—1 illustration. ... 41

IX. PSYCHOLOGY.—Anomalies of Vision.—By A. GRAEF. ... 45

X. TECHNOLOGY.—Illuminating Engineering. ... 35
Sugar Making By the Continuous Diffusion Process.—By H. ROUSSET.—3 illustrations. ... 36
Filters for Ultra-microscopical Particles—2 illustrations. ... 39
Trade Notes and Formulæ. ... 48